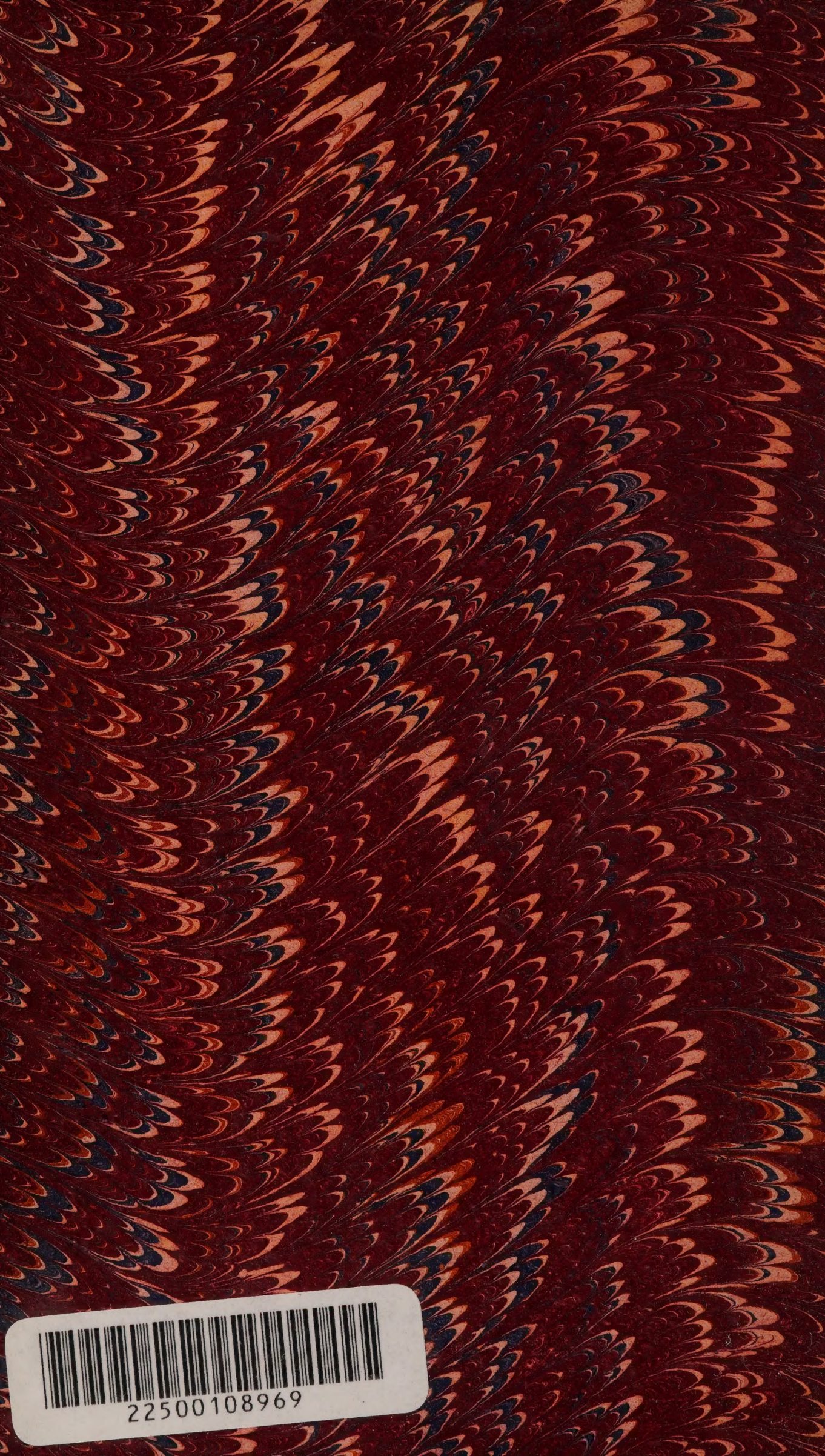

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J. Cubbington Thompson.

EIGHTEENTH ANNUAL REPORT

OF

THE LOCAL GOVERNMENT BOARD,

1888–89.

SUPPLEMENT

CONTAINING THE

REPORT OF THE MEDICAL OFFICER

For 1888.

Presented to both Houses of Parliament by Command of Her Majesty.

LONDON:
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BY EYRE AND SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

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EYRE AND SPOTTISWOODE, East Harding Street, Fleet Street, E.C., and 32, Abingdon Street, Westminster, S.W.; or
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PUBLIC HEALTH.

ANNUAL REPORT

OF THE

MEDICAL OFFICER

OF

THE LOCAL GOVERNMENT BOARD

FOR THE YEAR

1888.

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REPORT.

TO THE RIGHT HONOURABLE CHARLES THOMSON RITCHIE, M.P., PRESIDENT OF THE LOCAL GOVERNMENT BOARD.

Sir,

In the present Report I have the honour to submit to you, to be laid before Parliament, an account of the proceedings of your Medical Department during the year 1888. The Report is in supplement to the Eighteenth Annual Report of your Board. Introduction.

I find the number of references made to my Department for advice on matters of the Board's administrative business amounted during the year to over 6,000. Conferences of local authorities with the Department upon questions involving local sanitary considerations have been 52 in number. They have related principally to proposals for local byelaws, and to designs for borrowing money for local sanitary purposes. Requests for advice from the Colonial and other Government Offices have been received and complied with, and I note with satisfaction the increasing degree to which counsel and assistance is sought from the Department by Medical Officers of Health and others.

I.—*ADMINISTRATIVE RELATIONS OF THE MEDICAL DEPARTMENT.*

1. Vaccination and Public Vaccination.

The returns of vaccination officers made up to January 31st, 1888, have reference to the children whose births were registered in England and Wales during 1886. They form the first of the appended papers (A., No. 1), and they show 6·4 per cent., of the children born in 1886, to have been unaccounted for by the vaccination officers. For the metropolis the corresponding figure was 7·8; for the provinces it was 6·1; all these figures showing a noteworthy excess over those of the previous year. Vaccination.

For England and Wales, it is computed that the number of children born in 1886 and surviving to the date when the vaccination officers' returns were made up, was approximately 748,336, and that of these, 689,323 (or 92·1 per cent.) were at that date to be ranked in the vaccinated community, while 59,013 (or 7·9 per cent.) presumably went to swell the unvaccinated community.

Medical Officer's Report.

Public Vaccination.

Inspection of the vaccination afforded by public vaccinators was made as usual by the Medical Department. In the year 1888 (App. A., No. 2) 293 unions, comprising 1,410 vaccination districts, were visited. The satisfactory working of the arrangements for public vaccination which I have recorded in former years was observed at the inspections of 1888, and awards of money from the Parliamentary Grant were made to 998 public vaccinators who, having been in office during a prescribed period, had conformed to the conditions of their vaccination contracts and had properly performed the duties set forth in the Instructions of the Board.

National Vaccine Establishment.

The business of the National Vaccine Establishment (App. A., No. 3), administered by your Board, extended during the year 1888 to the collection of 9,655 capillary tubes and 2,841 ivory points charged with humanised vaccine, and of 107 capillary tubes and 21,155 ivory points charged with calf lymph. These supplies were distributed, in answer to 10,205 applications, to medical practitioners in England and Wales, and elsewhere. Five representations, but no more, of unsatisfactory results obtained with Establishment lymph were received from these practitioners.

Calf lymph.

During the year the operations of the Board's Animal Vaccine Station at Lamb's Conduit Street comprised 7,048 primary vaccinations and 208 re-vaccinations. Details as to the degree of success attained in these vaccinations are given by Dr. Cory in an appended report (Appendix A., No. 4).

Alleged vaccination injuries.

In England and Wales, during the year 1888, some seven hundred thousand vaccinations were performed by medical practitioners, public and private; and in the course of the year representations were received by the Board from 10 sources, alleging injury of one or another kind to have resulted from vaccination. Inquiry by Medical Inspectors showed two of these cases to be measles and whooping cough concurrent with vaccination, two to be of skin eruptions following on vaccination, and the remainder to be cases of erysipelas or similar disease.

At the end of 1888 the Registrar-General, by the Board's desire, issued a circular to local registrars requesting them to transmit to the Board copies of all death certificates in which vaccination was mentioned among the causes of death. It is intended to make immediate investigation of each such case, and to submit the total result to the Royal Commission which is about to sit on the subject of vaccination.

2. Other Administrative Relations of Medical Department.

Inquiries about small-pox.

Among the local inquiries made by Medical Inspectors during the year, one of these has already been mentioned in my previous Annual Report. Dr. Barry's investigation of the prevalence of *small-pox* in Sheffield, with his comprehensive Report upon the

subject, occupied him for several months during the year last past, and his history of the epidemic has already been presented to Parliament as a folio volume. Referring to this Report for the complete account of Dr. Barry's far-reaching investigation, I reprint by way of summary, particularly for those who will not ordinarily receive the separate volume, the matter with which I introduced this Report to your notice (Appendix A., No. 5).

I may refer at this place to one other inquiry that the Department had occasion to make into an outbreak of small-pox during the year 1888. It was a remarkable prevalence of the disease at an industrial school for girls at Manchester (Appendix A., No. 6). During the absence of small-pox from the city, the infection was introduced by a new comer, hardly ailing at the time of her arrival from a distance. The nature of the disease was unrecognised until a general outbreak occurred at the end of the second week after this girl's arrival. Besides the demonstration of the facility with which small-pox may be spread at an early stage of a patient's case, and from an obscure and trivial as well as from a severe case, the experience of this outbreak was chiefly interesting as illustrating how children, by the time that they arrive at about 10 years of age, may forfeit a portion of that protection against attack from small-pox which vaccination confers upon them in infancy.

Conferences held with sanitary authorities, and relating to the situation proper for isolation hospitals, the principle of construction of fever hospitals, and to adoption of local byelaws, have in 16 cases required visits by Medical Inspectors to the several localities. Conferences.

No investigation has yet been begun as to the methods by which small-pox hospitals may be so constructed as not to distribute infection from them to their neighbourhoods.

The other local inquiries by Medical Inspectors, enumerated on pages 63–74 (Appendix A., No. 7), have been made during the year in 36 instances, and have had reference to 52 sanitary districts. Occasion for these inspections arose in 11 cases out of appeal from the locality for the Board's assistance in controlling some prevalent disease; diphtheria, enteric fever, scarlatina, and epidemic pneumonia. In 19 cases, the occasion had consisted in a prevalence of the same or similar disease or in an exceptionally high general death-rate as reported by local health officers or by the Registrar-General. And in a third class of cases, 6 in number, but involving the interests of 13 sanitary districts, medical inspection had more direct reference to the administrative circumstances of the several cases. Grounds for local inspections.

Half of the inspections have had to take account of epidemic *diphtheria*. This disease has appeared to prevail under every Inquiries about diphtheria.

MEDICAL OFFICER'S REPORT.

variety of associated condition. As usual, it has been accompanied or its outbreak has been preceded by abundant cases of apparently innocent sore-throat, but this has not invariably been the case. As usual, a history of importation of the disease into a district and of its extension by personal intercourse was commonly forthcoming, but in some outbreaks any quality of infectiveness was barely discernible. As usual, schools habitually played a considerable part in the distribution if not in the production of epidemic diphtheria, but in some instances no such influence of schools was witnessed. As usual, the disease has been found to prevail where water has been polluted, where soil has been undrained, where excremental and other filth have accumulated, but it has also been found where these defects have not been present. As usual again, one or two outbreaks were to be connected with particular milk services under circumstances that left no doubt about milk having been a factor in the origin and spread of the local epidemic. Our observations have no doubt increased our experience of diphtheria; while they have afforded as many illustrations as we can desire of our ignorance of the proximate cause of its prevalence in England. In the absence of a systematic and sustained investigation of the circumstances of diphtheria generally, the country remains without means of adequately controlling the spread of the disease among its communities.

Diphtheria during 1888 has, in some localities of England, shown itself productive of as high a death-rate as in the Continental and American cities which it infests; but happily these English localities have seldom been large centres of populations. The customary English experience, of the incidence of diphtheria being rather upon small places than upon large urban districts, has, one year more, been repeated. But the instances of Norwich, and of Enfield and Walthamstow, in the neighbourhood of London, are in awkward accord with the evidence gathered by Dr. Longstaff* that of late years the larger towns of England appear to be approaching nearer than before to rural districts in their mortality from diphtheria.

The more instructive of the reports on this disease made by Inspectors of this Department during 1888 are printed at length as Nos. 8–14 of Appendix A. The investigations have related only to scattered outbreaks which had attained considerable dimensions at the time when inspection was directed.

Enteric fever.

The inquiries which have had concern with *enteric fever* have without exception† revealed conditions of excremental nuisances or befouled water supplies accompanying the prevalence of that

* Folio Supplement (C.—5638) to the 17th Annual Report of the Board.

† One instance of enteric fever being distributed along with milk, probably deserves to be included in this category.

disease. The methods by which air and water had become contaminated were not in all cases immediately obvious, but generally were matters of simple neglect or blundering on the part of sanitary authorities or their advisers. Two reports, describing the circumstances in which this disease has prevailed, are reproduced in Appendix A. (Nos. 15 and 16).

Scarlatina.

Of several reports upon local prevalence of *scarlatina*, one by Dr. Blaxall has reference to a long continued epidemic in a small Devonshire town, and is reprinted as Appendix A. No. 17. Along with matters of more medical interest, this report puts on record the story of a community utterly indifferent about its health or disease and receiving no adequate guidance from those who had assumed the function of directing its sanitary affairs.

Pneumonia.

In the early part of 1888, a considerable prevalence of *pneumonia* in Middlesbrough and its neighbourhood caused considerable anxiety among the sanitary authorities, and gave rise to request for the investigation of the subject by your Medical Department. Dr. Ballard was instructed for this duty, and he has reported upon his results (Appendix A., No. 18). He found himself confronted with intricate questions of causation and of the relation between every-day inflammation of the lung, and the particular disease epidemic in Middlesbrough. This disease about Middlesbrough was found to have produced four- or six-fold the usual mortality from "pneumonia" witnessed there in corresponding periods of other years; and it was seen to have its principal fatality on persons over 15 years of age. Comparison between the clinical and post-mortem appearances of the pneumonia at Middlesbrough during the epidemic, and of customary appearances in lung inflammation as seen about the country at large, were indeed suggestive of some minor differences; but there may be room for doubt whether the clinical and post-mortem appearances of the disease at Middlesbrough are not practically identical with pneumonia elsewhere.

What was presently observed at Middlesbrough to be peculiar to the prevailing disease was its strong tendency to occur in groups of cases, with sequence of the attacks among members of the same group, in the manner that is witnessed in diseases recognised as infective. The presence of local conditions of drain filth, also, unquestionably favoured the extension of this pneumonia; and furthermore, a suspicion that could not be set aside attached to food as having become contaminated with the material of the disease.

Thus the epidemic continued in and around Middlesbrough for six months or more. Meanwhile such pathological investigations as could be set on foot in the laboratory were conducted by Dr. Klein; and in his report (Addendum B. to Appendix A. No. 18, p. 314) he describes the reproduction of pneumonia by inoculation of rodents with morbid material taken from the lungs and air-passages of Middlesbrough patients, and he also

Medical Officer's Report.

gives an instructive account of subsequent attack of various animals by atmospheric spread of infection within his establishment. Certain bacilli, observed in expectoration and in the lung tissues of patients, could be identified and proved to be capable of growth upon appropriate culture-substances; and these bacilli upon further sub-culture were found as efficient as the original material to reproduce in rodents a pneumonia identical in character with the disease given to them direct from the human lung. The bacilli in question are described by Dr. Klein as having differential characters of their own, having no relation to other bacillary forms hitherto found in pneumonia.

Dr. Ballard, in the result, claims for the Middlesbrough epidemic pneumonia a place among the class of "acute specific fevers," and would call the disease by preference "pneumonic fever." The etiology and pathology of one and another kind of pneumonia is a subject fraught with equal importance to curative and preventive medicine; and the researches of Drs. Ballard and Klein will be welcomed as contributing to an understanding of the nature of lung inflammations generally.

Sanitary neglect.

I conclude the local inquiries which I have here to mention by reference to two reports made by the Medical Staff for the purposes of the more administrative objects of the Board. These reports give some examples of the kind of sanitary organisation still to be found in England during 1888. They relate to a Yorkshire village and to a group of Glamorganshire districts (Appendix A., Nos. 19 and 20).

§. Foreign Epidemic.

Cerebro-spinal meningitis.

The only foreign disease of the year that demands special comment by the Medical Department is *cerebro-spinal meningitis.* This disease was epidemic in certain districts of Cyprus, and was present, but not to a sufficient extent to be called epidemic, in some other islands of the Mediterranean and on the Austrian littoral. Such data as the Colonial Office had respecting the disease was supplemented by information obtained through the Foreign Office, and the whole are recorded by Dr. Thorne Thorne in the appended Paper A., No. 21.

The disease that was epidemic in Cyprus did not appear to be infectious from person to person, and in this respect it corresponded with the outbreaks that were observed in 1864–5 in villages on the Lower Vistula, and that were the subject of report by Dr. Sanderson to the Medical Department of the Privy Council (Eighth Report of Medical Officer). But for some years there have been observed in various counties (Landesbezirke) of Prussia (notably in certain towns of Oppeln county, in Upper Silesia), outbreaks of cerebro-spinal meningitis, in which German medical observers believe they have detected a certain infectious quality, and in respect of which the Prussian sanitary authorities

enjoin that every precaution be taken that is proper to be taken in the case of definitely contagious maladies.*

Of any such disease in England we have at present little experience. A dozen or two of fatal cases, scattered broadcast over the country, without any disposition to localise themselves, are each year returned to our Registrar-General as having been due to "cerebro-spinal fever," and the deaths are classed by him with the miasmatic diseases of his zymotic group. It cannot with confidence be affirmed that these sporadic cases are of the same nature with those now reported to us from Cyprus and elsewhere, still less can it be said that they have the quality of infectiveness believed to attach to the recent Prussian cases. But there is, in the fact of the occurrence of any such deaths in England, reason for watchfulness on the part of Health Authorities and their officers. A disease which kills from a quarter to half those whom it attacks, and leaves a large proportion of the survivors in a state of permanent incapacity, makes a demand to have its every single case identified.

II.—*AUXILIARY SCIENTIFIC INVESTIGATIONS.*†

Inquiries as to diseases affecting teats of cows.

Dr. Klein has during 1888 extended his researches (Appendix B., No. 1) into the characters and nature of those *teat eruptions upon milch cows* which have been considered in previous reports of this series. They have been shown to have abundant interest to man. To identify or to discriminate the various diseases exhibiting this common symptom of sore teats proves, as might have been expected, a work of no small labour. Those which agree in being inoculable from cows into calves differ from each other in their course and aspect, each one retaining its special character throughout a succession of animals; so these considerations alone would (if we may ignore possible developments, of which we are ignorant, of several diseases from one stock or of one disease from another disease) almost by themselves suffice for evidence of differences between the several diseases. The post-mortem appearances accompanying the several forms of eruption have gone far to confirm this belief in these differences of nature. And the evidences from bacteriology, so far as they go, tend to the same conclusions. Dr. Klein has used his opportunities of the past year to make further study of these eruptive diseases. In the course of his various researches, he has had frequent occasion to appeal to another kind of evidence respecting their pathological relations. Besides clinical, anatomical, and bacteriological methods he has largely used the test of successive inoculations of the same

* Veröffentlichungen des Kaiserl. Gesundheitsamtes, 1888, pp. 371 and 751.

† [P.S.—In my reports, which have been adorned by two remarkable essays (1885 and 1886) by Dr. Wooldridge, *on the Mode of Action of Pathogenic Organisms*, it is impossible not to chronicle—with a sense akin to dismay at so great a loss to sanitary medicine—the death of Dr. Wooldridge on June 6th, 1889, in the 32nd year of his age.]

animal with materials derived from one or another disease source, and by this inquiry as to insusceptibility he has arrived at sufficiently striking results.

Observations during 1888.

Dr. Klein has had under observation: (1) a cow from Kingston which proves to have been an example of that *dermatitis pustulosa* which was found in Wiltshire during 1887, and was described in my report of that year (page 215); (2) a cow from a dairy in Camberwell where scarlatina had appeared among customers of the dairy, and this cow was found to exhibit the same disease as those formerly recorded (in my reports of 1886 and 1887) as prevailing at Hendon, the disease, namely, which we now confidently recognise as *scarlatina in the cow;* and (3) a cow from Alderley in Gloucestershire which was shown, by inoculations of calves and ultimately of children, to have the characters of that "*variolæ vaccinæ*" which Jenner discovered in the same county last century, and which he put to the purpose of protecting against small-pox.

Study of diphtheria.

Dr. Klein has also extended his previous investigation of human *diphtheria.* In Appendix B., No. 2, he gives an account of his inoculations of the false membrane of this disease into the bodies of animals. He gets no definite results when rodents or birds are employed for the experiments, but he gets very notable results when he makes use of the domestic cat. Upon inoculation of these animals, he produces certain pathological conditions, differing indeed in certain respects from those of human diphtheria, yet bearing a general similarity to these, conditions too that are found to be capable of reproduction of themselves by inoculation of the new discharges into other healthy cats.* Much of this paper is devoted to the imperfectly understood subject of the bacteria found in diphtheria, and some significant results appear to have been reached by Dr. Klein during the year. For these I refer to the report itself. Dr. Klein is proposing to continue this promising branch of his studies.

Spores of bacteria.

In a third paper (Appendix B., No. 3), in furtherance of our knowledge of the *natural history of bacteria* in general, Dr. Klein has investigated some other obscure points of the formation of spores in these organisms. He finds that microscopical observation alone does not suffice to demonstrate the spore-nature of the more refractive particles observed in various bacteria, notably in bacilli. These particles may be, Dr. Klein contends, of a different nature, having nothing to do with propagation of the species. Neither is Dr. Klein content with the

* It will be remembered that Dr. George Turner (see Medical Officer's Report for 1886) saw reason for suspecting cats along with other domestic animals of being concerned in the spread of some epidemics which he investigated for the Board. Similar suspicions about cats have been entertained by other sanitary observers; and these indeed gave rise to cats being used in an early stage of Dr. Klein's experiments.

evidence afforded by the customary drying tests as to the nature of the bodies in question. He proposes, as a further and perhaps more decisive test, the test of exposure to heat; examining the presence or absence of growth in such particles after they have been exposed, under suitable arrangements, to a temperature of 70° C.: and as the result of numerous observations by these means he pronounces a decision upon what had before been in doubt respecting the spore-nature of certain of these microscopical particles.

Plumbo-solvent water-supplies.

A number of specimens of acid *waters*, possessed of the power to *dissolve lead*, have been obtained from Sheffield; and examination has been made by Dr. W. R. Smith of the organised forms contained in them (Appendix B., No. 4). Some useful information, but principally of a negative kind, has been obtained, and it is proposed to continue the research. But it has become abundantly manifest that laboratory studies cannot profitably supersede investigation of the circumstances of origin of waters of this class. Examination of these moorland waters ought to be simultaneously made at their various gathering grounds. And the object of these combined studies should be to learn the conditions under which these waters *acquire their power* of dissolving lead; upon which knowledge rests the decision whether or not an elaborate and dubious process has to be applied to a water, in order to fit it for domestic use under the customary conditions of a community.

Scrofula, lupus, and tubercle.

Dr. Lingard has contributed to this report a paper of much importance for general pathology concerning the relations of scrofula, lupus, and tuberculosis (Appendix B., No. 5). By experiments on guinea-pigs he finds confirmation of those observers who have heretofore maintained that these three diseases belong to the one group of true tubercular diseases. He records the same bacillary forms present in the organs of these animals, alike whether the inoculating material has been derived from one or another of these diseases. He records morbid processes in the animals being effected, alike from each of the three sources of material: the difference between these processes appearing to be little else that what he would ascribe to the differing rapidity of operation in the case of the several materials. In this respect, however, Dr. Lingard finds very marked differences; the action of material inoculated into guinea-pigs is notably most rapid when the material has been derived from general tuberculosis, and least rapid when the material has been derived from lupus.

Chemistry and vital processes of differentiated bacteria.

Three years ago, when reporting Dr. Dupré's investigation of the chemical actions of water-bacteria, and commenting on the inquiries of the Department about disinfectants, I had occasion to insist on the need of identifying harmless bacteria, and for research into their ways as well as into the habits of bacteria

which are concerned in disease. In the present volume are two contributions to these subjects (Appendix B., Nos. 6 and 7) : one by Dr. McFadyen dealing more especially with their chemical relations, and the other by Dr. V. D. Harris, treating of certain bacteria under biological aspects. Dr. McFadyen commences his paper by a synopsis of our present knowledge respecting the metabolic products of bacterial life, illustrating very abundantly, as his review proceeds, the highly complex nature of the problems that workers in this field have set themselves to attack. It was desired to use Dr. McFadyen's wide knowledge of bacteria, of their life history and chemistry, to analyse the results announced by his predecessors, especially for learning about products from particular species of bacteria. At the outset of such researches, he came upon (as might be expected) indications of varying chemical operation upon the same substance, exerted by one and another of organisms that had been habitually grouped together as being "putrefactive," or having some other aggregate property. It is intended to pursue this interesting line of inquiry with the assistance of Dr. Harris and Dr. Sidney Martin.

I have the honour to be,

Sir,

Your obedient servant,

GEORGE BUCHANAN.

March 1889.

APPENDICES.

APPENDICES.

APPENDIX A.

No. 1.

App. A. No. 1

Digest of Vaccination Officers' Returns.

DIGEST of the VACCINATION OFFICERS' RETURNS, with regard to CHILDREN whose BIRTHS were registered in the Year 1886.

The following is the fifteenth annual return under the Vaccination Act, 1871. Of 903,846 births returned to the Board by the several Vaccination Officers in England and Wales as registered during the year 1886, the number which at the time the return was made had been registered as successfully vaccinated was 754,059. This number is 83·4 per cent. of the whole. The children whose births were registered during the year, and who were not recorded as successfully vaccinated, numbered 149,787. Of this number, 90,774 were registered as having died unvaccinated.* Out of the same number, 1,278 had been registered as insusceptible of vaccination; 20 as having contracted small-pox and, therefore, not needing to be vaccinated; 10,187 as having their vaccination postponed by medical certificate; and there remained on the Vaccination Officers' registers 47,528 children born in 1886, who had "removed," were "not to be traced," or were otherwise unaccounted for. If from the 903,846 births returned by these officers deduction of the deaths without vaccination be first made, it appears that of the remaining 813,072 children, there were registered at the time of the return 92·7 per cent. as successfully vaccinated; 0·16 per cent. as either insusceptible of vaccination, or as having had small-pox; and 1·3 per cent. as under medical certificate of postponement; leaving 5·8 per cent. as at that time still unaccounted for as regards vaccination. The per-centage of children not finally accounted for (*i.e.* including cases postponed) was 6·4 of the total births (903,846); and this figure is given in the table on page 3, in sequence to the records of former years.

By the latter method of computation, it appears that the proportion of cases not finally accounted for in the metropolitan returns for 1886 was 7·8 per cent.; in the provincial returns, 6·1. Of the registered births of the fifteen years 1872–86, the corresponding proportion not finally accounted for in regard to vaccination in each year respectively has been as follows:—

	Metropolis.	Rest of England.		Metropolis.	Rest of England.
1872	8·8	4·5	1880	7·0	4·5
1873	8·7	4·2	1881	5·7	4·3
1874	8·8	4·1	1882	6·6	4·5
1875	9·3	3·8	1883	6·5	4·9
1876	6·5	4·0	1884	6·8	5·3
1877	7·1	4·1	1885	7·0	5·5
1878	7·1	4·3	1886	7·8	6·1
1879	7·8	4·5			

* Of vaccinated children, dying before the returns are made up, no record is kept.

	Metropolis.	Rest of England.
Average of 5 years, 1873–77 -	8·1	4·1
" " 1878–82 -	6·8	4·4

In 1886, the proportion of cases unaccounted for, after deduction of postponed cases, in the metropolis and in the rest of the kingdom, was 6·9 and 5·0 per cent. respectively.

Note by the Medical Officer.

As in my Report for last year, I am desirous of calculating, upon such data as are available, the number of children who, at the time the Vaccination Officers' Returns are made up, pass into the vaccinated class of the population, and the number that pass into the unvaccinated class. The result expressed in per-centages of the two classes cannot, I know, be absolutely correct; but I have satisfied myself that it cannot differ from the truth by more than a fraction of a unit per cent.

Vaccination Officers' Returns are made up to January 31st of the year but one following that to which returns relate. The interval between birth and return must therefore always be a twelvemonth and something more. This "something more" may be as little as one month, or as much as 13 months, according as the child is born at the beginning or the end of a calendar year:—the mean of the one and 13 months is seven months. [The following has reference to the Returns now presented.]

Let us as a first step examine the total mortality so far as recorded by the Registrar-General for the above period of childrens' lives, and apply our examination to the case of children born in 1886. We may take as a fair approximation to the mortality of children born in 1886 and dying during the first twelvemonth of life, the mean mortality at ages 0–1 of the years 1886–87; namely, 131,573.

We may take as a fair approximation to the mortality of children born in 1886, surviving their first year and dying in the course of 1–13 months afterwards, seven-twelfths of the mortality at ages 1–2 of the year 1887; namely: $\frac{7}{12} \times 41{,}035 = 23{,}937$.

The sum of the two figures 131,573 and 23,937 (viz.:—155,510) represents then with sufficient accuracy the total mortality occurring up to January 31st, 1888, among the children born in 1886. But the births of 1886 numbered 903,846, and therefore there remains a balance of 748,336 children, vaccinated and unvaccinated together born in 1886 and surviving January 31st, 1888.

As a second step let us examine the returns of the Vaccination Officers made up to January 31st, 1888, and relating to the births of 1886. We find there a record of 90,774 deaths known to have occurred among unvaccinated children.

We find from the same returns a number of children born in 1886, and recorded as neither dead nor vaccinated on January 31st, 1888. The number of these unvaccinated survivors at the date in question was 59,013.

The difference between the total survivors and the unvaccinated survivors represents the number of children born in 1886 who, having been vaccinated, survived January 31st, 1888, the date to which Vaccination Officers' returns for 1886 are made up. This number is 689,323; vaccinated survivors.

[These numbers no doubt may deviate a little on one or the other side, from the precise number of deaths and survivals; but the deviations cannot be very large, and some of them would seem compensatory of each other.]

On February 1st, 1888, therefore the survivors of those born in 1886 were pretty closely as follows:—

Vaccinated children - - -	689,323	748,336
Unvaccinated children - -	59,013	

or, per cent of all survivors,

Vaccinated children - - - -	92·1
Unvaccinated children - - - -	7·9

[I have said "pretty closely"; and a judgment may be formed of the extent of any probable error by noting that the transfer of 1,000 from the one to the other number would alter the respective per-centages by less that a quarter per cent.]

This per-centage 7·9 is made up of—

0·17 per cent. (1,298) certified as insusceptible of vaccination or as having already had small-pox.

1·36 " (10,187) vaccination postponed by medical certificate.

6·4 " (47,528) unaccounted for.

G. B.

App. A. No. 1.

Digest of Vaccination Officers' Returns.

—	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
ENGLAND & WALES -	903,846	754,059	1,278	20	90,774	10,187	47,528	6·4
Ditto (excluding Metropolitan Unions).	769,475	643,854	933	20	77,471	8,898	38,299	6·1
METROPOLITAN UNIONS -	134,371	110,205	345	—	13,303	1,289	9,229	7·8
COUNTIES.								
ENGLAND:								
Bedford - - -	5,165	3,919	4	—	594	99	549	12·5
Berks - - -	7,784	6,752	3	—	672	150	207	4·6
Bucks - - -	5,002	4,324	5	—	472	72	129	4·0
Cambridge - -	5,744	5,004	8	1	555	63	113	3·1
Chester - - -	20,873	17,980	30	—	2,077	176	610	3·8
Cornwall - - -	9,510	7,929	4	—	1,149	193	235	4·5
Cumberland - -	8,678	7,556	5	—	789	132	196	3·8
Derby - -	14,034	11,850	13	—	1,346	182	643	5·9
Devon - - -	17,913	15,511	25	—	1,656	199	522	4·0
Dorset - - -	5,436	4,733	—	—	416	73	214	5·3
Durham - - -	35,726	30,077	33	1	3,756	444	1,415	5·2
Essex - - -	22,852	19,197	28	—	2,004	320	1,303	7·1
Gloucester - -	16,119	13,629	28	—	1,444	196	822	6·3
Hereford - - -	3,160	2,724	—	—	295	48	93	4·5
Herts - - -	7,408	6,439	6	—	671	84	208	3·9
Huntingdon - -	1,502	1,352	1	—	126	8	15	1·5
Kent (extra-metrop.) -	23,835	20,294	37	2	2,204	205	1,093	5·4
Lancaster- - -	131,223	108,152	173	3	14,460	1,505	6,930	6·4
Leicester - - -	12,243	6,558	5	—	1,686	83	3,911	32·6
Lincoln - - -	14,379	12,031	16	7	1,556	188	581	5·3
Middlesex (ex.-metro.)	14,961	12,153	33	—	1,360	212	1,203	9·5
Monmouth - -	9,044	7,771	4	—	878	111	280	4·3
Norfolk - - -	13,993	11,919	12	—	1,471	211	380	4·2
Northampton - -	9,305	7,211	9	—	978	116	991	11·9
Northumberland -	16,476	14,173	31	—	1,709	245	318	3·4
Nottingham - -	17,498	14,241	27	—	1,953	228	1,049	7·3
Oxford - - -	5,615	4,729	2	—	506	77	301	6·7

App. A. No. 1.

Digest of Vaccination Officers' Returns.

	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
COUNTIES—*cont.*								
ENGLAND—*cont.*								
Rutland	633	542	1	—	60	4	26	4·7
Salop	7,646	6,676	5	—	702	80	183	3·4
Somerset	14,880	12,794	20	—	1,304	263	499	5·1
Southampton	18,915	16,455	30	—	1,575	249	606	4·5
Stafford	33,323	28,139	39	1	3,524	231	1,389	4·9
Suffolk	11,455	9,926	13	—	1,036	182	298	4·2
Surrey (extra-metro.)	14,909	12,901	31	—	1,211	183	583	5·1
Sussex	14,678	12,557	19	—	1,220	213	669	6·0
Warwick	24,859	20,873	33	—	2,594	203	1,156	5·5
Westmoreland	1,850	1,688	3	—	123	20	16	1·9
Wilts	7,335	6,506	10	—	563	129	127	3·5
Worcester	18,704	16,353	19	2	1,811	111	408	2·8
York, East Riding	12,573	10,229	26	—	1,426	114	778	7·1
York, North Riding	11,599	9,991	16	1	1,127	149	315	4·0
York, West Riding	74,437	59,898	99	2	7,904	634	5,900	8·8
WALES:								
Anglesey	946	826	1	—	89	8	22	3·2
Brecknock	1,587	1,388	1	—	151	19	28	3·0
Cardigan	1,771	1,563	—	—	160	17	31	2·7
Carmarthen	4,184	3,740	1	—	368	37	38	1·8
Carnarvon	3,321	2,905	3	—	324	32	57	2·7
Denbigh	2,574	2,246	4	—	239	48	37	3·3
Flint	2,416	2,114	—	—	205	28	69	4·0
Glamorgan	22,457	19,366	14	—	2,306	161	610	3·4
Merioneth	1,898	1,615	1	—	208	42	32	3·9
Montgomery	2,019	1,783	—	—	165	37	34	3·5
Pembroke	2,506	2,133	1	—	239	79	54	5·3
Radnor	522	439	1	—	54	5	23	5·4

APP. A. No. 1.

Digest of Vaccination Officers' Returns.

METROPOLITAN UNIONS.	RETURNS, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
Bethnal Green - -	5,204	4,040	6	—	579	14	565	11·1
Camberwell - - -	7,362	6,009	16	—	718	43	576	8·4
Chelsea - - -	3,266	2,670	5	—	408	24	159	5·6
Fulham - - -	5,520	4,729	18	—	522	22	229	4·5
George, St., Hanover Sq. -	3,478	2,971	17	—	339	22	129	4·3
George, St., in the East -	1,821	1,505	—	—	220	4	92	5·3
Giles, St., and St. George -	1,273	1,007	1	—	110	6	149	12·2
Greenwich - - -	5,321	4,158	16	—	543	132	472	11·4
Hackney - - -	6,689	5,359	25	—	686	105	514	9·3
Hampstead - - -	1,340	1,161	7	—	118	8	46	4·0
Holborn - - -	5,281	4,273	11	—	589	35	373	7·7
Islington - - -	9,844	7,944	39	—	1,091	148	622	7·8
Kensington - - -	4,153	3,479	9	—	393	31	241	6·5
Lambeth - - -	9,085	7,243	37	—	954	96	755	9·4
Lewisham - - -	2,378	2,077	8	—	175	12	106	5·0
London, City of - -	829	662	2	—	99	8	58	8·0
Marylebone - - -	4,697	3,949	5	—	525	56	162	4·6
Mile End Old Town -	4,087	3,312	11	—	367	23	374	9·7
Olave, St. - - -	5,176	4,214	6	—	490	71	395	9·0
Paddington - - -	2,923	2,409	7	—	213	26	268	10·1
Pancras, St. - -	7,636	6,403	24	—	682	58	469	6·9
Poplar - - -	6,330	5,473	10	—	536	15	296	4·9
Saviour, St. - -	7,347	5,508	7	—	870	42	920	13·1
Shoreditch - - -	4,790	4,190	—	—	300	33	267	6·3
Stepney - - -	2,106	1,773	6	—	202	—	125	5·9
Strand - - -	668	522	1	—	88	1	56	8·5
Wandsworth and Clapham	8,948	7,192	40	—	851	210	655	9·7
Westminster - -	969	772	3	—	112	24	58	8·5
Whitechapel - -	2,538	2,253	2	—	238	5	40	1·8
Woolwich - - -	3,312	2,948	6	—	285	15	58	2·2
	134,371	110,205	345	—	13,303	1,289	9,229	7·8

App. A. No. 1

Digest of Vaccination Officers' Returns.

—	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed) per cent. of births.
BEDFORD.								
Ampthill - - -	486	425	—	—	47	6	8	2·9
Bedford - - -	1,361	1,126	—	—	124	34	77	8·2
Biggleswade - - -	892	774	—	—	91	7	20	3·0
Leighton Buzzard - -	613	516	2	—	70	3	22	4·1
Luton - - -	1,557	860	2	—	233	48	414	29·7
Woburn - - -	256	218	—	—	29	1	8	3·5
BERKS.								
Abingdon - - -	656	580	—	—	57	1	18	2·9
Bradfield - - -	610	543	—	—	50	7	10	2·8
Cookham - - -	572	503	—	—	45	12	12	4·2
Easthampstead - -	374	356	—	—	13	—	5	1·3
Faringdon - - -	410	370	1	—	21	5	13	4·4
Hungerford - - -	528	474	—	—	44	7	3	1·9
Newbury - - -	609	516	—	—	59	21	13	5·6
Reading - - -	1,516	1,247	1	—	166	67	35	6·7
Wallingford - - -	400	359	—	—	31	4	6	2·5
Wantage - - -	538	474	1	—	49	7	7	2·6
Windsor - - -	942	781	—	—	90	9	62	7·5
Wokingham - - -	629	549	—	—	47	10	23	5·2
BUCKS.								
Amersham - - -	626	560	—	—	52	11	3	2·2
Aylesbury - - -	777	615	—	—	85	38	39	9·9
Buckingham - -	314	272	—	—	22	4	16	6·4
Eton - - - -	802	721	1	—	56	6	18	3·0
Newport Pagnell - -	820	720	1	—	73	3	23	3·2
Winslow - - -	246	219	1	—	24	1	1	0·8
Wycombe - - -	1,417	1,217	2	—	160	9	29	2·7
CAMBRIDGE.								
Cambridge - - -	1,003	854	2	—	113	16	18	3·4
Caxton and Arrington -	306	281	—	—	22	—	3	1·0
Chesterton - - -	826	724	1	—	76	7	18	3·0
Ely - - - -	650	549	1	—	76	7	17	3·7
Linton - - -	396	351	2	—	32	3	8	2·8
Newmarket - - -	928	832	—	—	84	4	8	1·3
North Witchford - -	555	496	1	1	44	8	5	2·3
Whittlesey - - -	174	142	—	—	18	9	5	8·0
Wisbech - - -	906	775	1	—	90	9	31	4·4
CHESHIRE.								
Altrincham - - -	1,734	1,557	1	—	135	20	21	2·4
Birkenhead - - -	4,104	3,604	2	—	388	29	81	2·7
Chester - - -	1,481	1,304	1	—	130	5	41	3·1
Congleton - - -	1,131	996	3	—	110	11	11	1·9
Macclesfield - - -	1,792	1,556	1	—	191	21	23	2·5
Nantwich - - -	2,256	1,851	2	—	258	29	116	6·4
Northwich - - -	1,769	1,585	1	—	151	9	23	1·8
Runcorn - - -	1,262	1,134	1	—	112	5	10	1·2
Stockport - - -	4,116	3,315	17	—	509	35	240	6·7
Tarvin - - -	322	286	—	—	33	—	3	0·9
Wirral - - -	906	792	1	—	60	12	41	5·8

	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
CORNWALL.								
Austell, St.	949	853	—	—	77	14	5	2·0
Bodmin	530	473	—	—	49	4	4	1·5
Camelford	217	192	—	—	21	2	2	1·8
Columb, St., Major	446	387	—	—	48	3	8	2·5
Falmouth	627	475	1	—	93	11	47	9·3
Germans, St.	474	412	1	—	48	5	8	2·7
Helston	710	575	—	—	110	12	13	3·5
Launceston	467	426	—	—	36	1	4	1·1
Liskeard	793	693	—	—	66	19	15	4·3
Penzance	1,531	1,262	—	—	187	50	32	5·4
Redruth	1,584	1,222	2	—	299	27	34	3·9
Stratton	209	193	—	—	10	4	2	2·9
Truro	973	766	—	—	105	41	61	10·5
CUMBERLAND.								
Alston-with-Garrigill	104	95	—	—	7	2	—	1·9
Bootle	485	440	—	—	37	1	7	1·6
Brampton	274	234	—	—	25	11	4	5·5
Carlisle	1,719	1,511	1	—	167	20	20	2·3
Cockermouth	2,361	1,985	1	—	234	64	77	6·0
Longtown	221	196	—	—	18	4	3	3·2
Penrith	790	638	—	—	46	2	4	0·9
Whitehaven	2,118	1,853	2	—	191	9	63	3·4
Wigton	706	604	1	—	64	19	18	5·2
DERBY.								
Ashbourne	590	525	—	—	41	5	19	4·1
Bakewell	875	765	2	—	65	13	30	4·9
Belper	2,128	1,922	1	—	178	9	18	1·3
Chapel-en-le-Frith	618	555	2	—	38	13	10	3·7
Chesterfield	3,854	3,059	3	—	395	85	312	16·3
Derby	2,896	2,363	2	—	328	37	166	7·0
Glossop	780	650	1	—	91	5	33	4·9
Hayfield	382	331	1	—	44	1	5	1·6
Shardlow	1,911	1,680	1	—	166	14	50	3·3
DEVON.								
Axminster	469	416	—	—	37	2	14	3·4
Barnstaple	1,100	976	4	—	88	16	16	2·9
Bideford	591	518	—	—	67	5	1	1·0
Crediton	509	466	2	—	34	2	5	1·4
East Stonehouse	588	479	—	—	77	18	14	5·4
Exeter	1,053	874	—	—	127	23	29	4·9
Holsworthy	288	263	—	—	23	1	1	0·7
Honiton	642	547	2	—	47	4	42	7·2
Kingsbridge	482	450	—	—	29	1	2	0·6
Kewton Abbot	1,921	1,690	3	—	182	15	31	2·4
Okehampton	493	430	—	—	51	10	2	2·4
Plymouth	2,424	1,980	6	—	275	21	142	6·7
Plympton St. Mary	689	592	—	—	60	17	20	5·4
Southmolton	481	439	1	—	31	6	4	2·1
Stoke Damerel	1,678	1,363	4	—	183	16	112	7·6
Tavistock	808	731	—	—	71	1	5	0·7
Thomas, St.	1,364	1,195	2	—	99	20	48	5·0
Tiverton	847	743	1	—	80	3	20	2·7
Torrington	411	363	—	—	34	8	6	3·4
Totnes	1,075	996	—	—	61	10	8	1·7

App. A. No. 1.

Digest of Vaccination Officers' Returns

	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
DORSET.								
Beaminster	344	309	—	—	24	3	8	3·2
Blandford	358	297	—	—	32	7	22	8·1
Bridport	415	367	—	—	28	11	9	4·8
Cerne	164	148	—	—	12	2	2	2·4
Dorchester	530	463	—	—	45	4	18	4·2
Poole	733	641	—	—	72	7	13	2·7
Shaftesbury	360	318	—	—	23	4	15	5·3
Sherborne	325	287	—	—	22	6	10	4·9
Sturminster	286	260	—	—	13	1	12	4·5
Wareham and Purbeck	541	494	—	—	36	6	5	2·0
Weymouth	824	663	—	—	63	10	88	11·9
Wimborne and Cranborne	556	486	—	—	46	12	12	4·3
DURHAM.								
Auckland	3,132	2,609	—	—	361	33	129	5·2
Chester-le-Street	1,921	1,602	3	—	232	16	68	4·4
Darlington	1,589	1,367	5	—	144	5	68	4·6
Durham	2,530	2,193	2	—	255	17	63	3·2
Easington	1,990	1,722	—	—	222	16	30	2·3
Gateshead	4,440	3,705	6	—	482	58	189	5·6
Hartlepool	2,160	1,853	4	1	223	37	42	3·7
Houghton-le-Spring	1,512	1,290	3	—	190	9	20	1·9
Lanchester	2,259	1,972	2	—	223	16	46	2·7
Sedgefield	709	610	—	—	76	11	12	3·2
South Shields	4,755	3,572	2	—	557	152	472	13·1
Stockton	1,929	1,594	—	—	203	9	123	6·8
Sunderland	5,603	4,925	4	—	488	55	131	3·3
Teesdale	630	545	2	—	56	9	18	4·3
Weardale	567	518	—	—	44	1	4	0·9
ESSEX.								
Billericay	520	438	1	—	47	6	28	6·5
Braintree	810	721	—	—	65	12	12	3·0
Chelmsford	1,004	867	—	—	99	15	23	3·8
Colchester	945	774	1	—	98	14	58	7·6
Dunmow	447	405	—	—	33	6	3	2·0
Epping	714	627	1	—	51	8	27	4·9
Halstead	477	424	—	—	40	6	7	2·7
Lexden and Winstree	664	601	1	—	54	3	5	1·2
Maldon	730	647	—	—	61	6	12	2·5
Ongar	294	259	—	—	24	5	6	3·7
Orsett	918	728	1	—	83	5	101	11·5
Rochford	828	709	—	—	82	9	28	4·5
Romford	1,591	1,315	2	—	159	25	90	7·2
Saffron Walden	555	500	—	—	40	6	9	2·7
Tendring	1,086	956	1	—	101	13	15	2·6
West Ham	11,269	9,226	20	—	963	181	879	9·4
GLOUCESTER.								
Barton Regis	5,783	5,023	22	—	510	36	192	3·9
Bristol	1,595	1,331	2	—	181	6	75	5·1
Cheltenham	1,421	1,051	1	—	165	38	166	14·4
Chipping Sodbury	504	465	1	—	27	4	7	2·2
Cirencester	558	502	1	—	35	11	9	3·6
Dursley	338	289	—	—	24	8	17	7·4
Gloucester	1,467	1,095	—	—	106	24	242	18·1
Newent	293	256	—	—	29	6	2	2·7
Northleach	226	200	—	—	17	4	5	4·0

	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
GLOUCESTER—*cont.*								
Stow-on-the-Wold	280	246	1	—	21	3	9	4·3
Stroud	1,231	1,086	—	—	106	10	29	3·2
Tetbury	174	148	—	—	15	4	7	6·3
Tewkesbury	367	320	—	—	36	4	7	3·0
Thornbury	557	488	—	—	35	9	25	6·1
Westbury-on-Severn	817	680	—	—	100	17	20	4·5
Wheatenhurst	233	211	—	—	13	4	5	3·9
Winchcomb	275	238	—	—	24	8	5	4·7
HEREFORD.								
Bromyard	310.	264	—	—	32	6	8	4·5
Dore	219	188	—	—	18	7	6	5·9
Hereford	947	804	—	—	103	16	24	4·2
Kington	343	290	—	—	42	4	7	3·2
Ledbury	315	272	—	—	26	2	15	5·4
Leominster	350	303	—	—	28	5	14	5·4
Ross	440	394	—	—	33	3	10	3·0
Weobley	236	209	—	—	13	5	9	5·9
HERTS.								
Albans, St.	788	698	1	—	61	6	22	3·6
Barnet	1,157	885	2	—	154	36	80	10·0
Berkhampstead	485	427	—	—	50	1	7	1·6
Bishop's Stortford	601	558	—	—	37	1	5	1·0
Buntingford	144	129	—	—	10	2	3	3·5
Hatfield	220	196	—	—	14	4	6	4·5
Hemel Hempstead	476	413	1	—	48	3	11	2·9
Hertford	484	426	—	—	45	5	8	2·7
Hitchin	921	803	—	—	95	5	18	2·5
Royston	532	465	—	—	44	10	13	4·3
Ware	565	516	—	—	40	1	8	1·6
Watford	965	856	2	—	70	10	27	3·8
Welwyn	70	67	—	—	3	—	—	0·0
HUNTINGDON.								
Huntingdon	552	494	1	—	47	3	7	1·8
Ives, St.	469	418	—	—	47	3	1	0·9
Neots, St.	481	440	—	—	32	2	7	1·9
KENT (Extra-Metropolitan).								
Ashford, East	433	382	—	—	32	4	15	4·4
Ashford, West	602	512	—	—	57	12	21	5·5
Blean	553	487	—	—	54	4	8	2·2
Bridge	341	304	1	—	24	5	7	3·5
Bromley	1,848	1,499	1	—	229	41	78	6·4
Canterbury	531	463	—	—	54	3	11	2·6
Cranbrook	398	354	—	—	28	2	14	4·0
Dartford	1,871	1,609	3	—	144	16	99	6·1
Dover	1,139	825	3	—	113	22	176	17·4
Eastry	813	722	—	—	75	1	15	2·0
Elham	1,112	916	2	—	118	4	72	6·8
Faversham	934	826	3	—	91	1	13	1·5
Gravesend and Milton	819	591	2	—	75	1	150	18·4
Hollingbourn	414	376	—	—	28	—	10	2·4
Hoo	141	121	—	—	17	1	2	2·1
Maidstone	1,548	1,239	1	—	193	9	106	7·4

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KENT (Extra-Metropolitan)—*cont.*								
Malling	950	832	2	—	83	6	27	3·5
Medway	2,372	2,082	6	—	193	12	79	3·8
Milton	844	746	1	—	78	10	9	2·3
Romney Marsh	193	177	—	—	14	1	1	1·0
Sevenoaks	851	730	—	—	68	13	40	6·2
Sheppey	556	484	3	—	47	6	16	4·0
Strood	1,239	1,070	2	1	122	4	40	3·6
Tenterden	311	279	1	1	21	2	7	2·9
Thanet, Isle of	1,458	1,289	3	—	138	9	19	1·9
Tonbridge	1,564	1,379	3	—	108	16	58	4·7
LANCASHIRE.								
Ashton-under-Lyne	5,388	4,310	7	—	675	38	358	7·3
Barrow-in-Furness	1,815	1,620	3	—	138	12	42	3·0
Barton-upon-Irwell	2,633	2,232	1	—	209	76	115	7·3
Blackburn	6,554	5,656	6	—	731	45	116	2·5
Bolton	7,050	6,332	9	—	624	12	73	1·2
Burnley	5,013	3,784	1	—	616	22	590	12·2
Bury	4,299	3,760	15	—	447	13	64	1·8
Chorley	1,706	1,461	1	—	150	—	94	5·5
Chorlton	9,246	7,383	9	—	1,111	145	598	8·0
Clitheroe	653	579	1	—	46	11	16	4·1
Fylde, The	1,417	1,236	2	—	135	20	24	3·1
Garstang	344	303	—	—	23	—	18	5·2
Haslingden	3,074	2,681	4	—	311	21	57	2·5
Lancaster	1,462	1,288	—	—	140	11	23	2·3
Leigh	2,475	2,120	6	—	281	13	55	2·7
Liverpool	6,022	4,965	5	1	763	6	282	4·8
Lunesdale	209	191	—	—	17	—	1	0·5
Manchester	5,376	4,481	6	—	671	57	161	4·1
Oldham	6,388	3,798	22	—	804	173	1,591	27·6
Ormskirk	2,759	2,410	1	—	282	21	45	2·4
Prescot	4,967	4,073	5	—	627	91	171	5·3
Preston	4,973	3,981	5	1	669	30	287	6·4
Prestwich	4,871	4,084	8	—	433	27	319	7·1
Rochdale	3,348	2,878	7	1	318	29	115	4·3
Salford	7,480	5,905	14	—	969	176	416	7·9
Todmorden	915	786	—	—	101	—	28	3·1
Toxteth Park	4,564	3,547	15	—	529	109	364	10·4
Ulverston	1,491	1,316	1	—	116	37	21	3·9
Warrington	2,904	2,456	6	—	338	19	85	3·6
West Derby	15,527	13,120	11	—	1,499	218	679	5·8
Wigan	6,300	5,416	2	—	687	73	122	3·1
LEICESTER.								
Ashby-de-la-Zouch	1,205	1,032	—	—	127	10	36	3·8
Barrow-on-Soar	1,099	723	1	—	145	12	218	20·9
Billesdon	345	240	—	—	42	1	62	18·3
Blaby	1,050	782	2	—	127	11	128	13·2
Hinckley	656	562	—	—	73	6	15	3·2
Leicester	4,864	655	2	—	847	3	3,357	69·1
Loughborough	1,037	845	—	—	132	22	38	5·8
Lutterworth	332	302	—	—	22	1	7	2·4
Market Bosworth	512	433	—	—	56	8	15	4·5
Market Harborough	470	402	—	—	44	3	21	5·1
Melton Mowbray	673	582	—	—	71	6	14	3·0

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LINCOLNSHIRE.								
Boston	1,103	950	1	—	94	16	42	5·3
Bourn	577	495	1	—	60	6	15	3·6
Caistor	2,589	2,073	3	7	320	49	137	7·2
Gainsborough	1,066	858	1	—	114	18	75	8·7
Glanford Brigg	1,323	1,125	—	—	146	13	39	3·9
Grantham	1,074	916	2	—	111	6	39	4·2
Holbeach	543	464	1	—	40	11	27	7·0
Horncastle	601	547	—	—	39	4	11	2·5
Lincoln	2,082	1,643	4	—	312	27	96	5·9
Louth	861	729	1	—	74	22	35	6·6
Sleaford	699	618	—	—	70	2	9	1·6
Spalding	621	531	—	—	63	7	20	4·3
Spilsby	774	689	2	—	63	5	15	2·6
Stamford	466	393	—	—	50	2	21	5·0
MIDDLESEX (EXTRA-METROPOLITAN).								
Brentford	3,774	3,064	16	—	389	10	295	8·1
Edmonton	6,975	5,707	11	—	600	137	520	9·4
Hendon	2,611	1,981	4	—	240	47	339	14·8
Staines	740	636	1	—	63	13	27	5·4
Uxbridge	861	765	1	—	68	5	22	3·1
MONMOUTHSHIRE.								
Abergavenny	775	687	—	—	70	4	14	2·3
Bedwelty	2,327	1,968	—	—	237	32	90	5·2
Chepstow	555	481	—	—	57	7	10	3·1
Monmouth	823	717	—	—	74	15	17	3·9
Newport	3,255	2,807	4	—	315	34	95	4·0
Pontypool	1,309	1,111	—	—	125	19	54	5·6
NORFOLK.								
Aylsham	513	471	—	—	32	4	6	2·0
Blofield	406	360	—	—	42	1	3	1·0
Depwade	695	604	—	—	57	18	16	4·9
Docking	480	411	—	—	55	6	8	2·9
Downham	576	490	—	—	65	11	10	3·6
Erpingham	510	430	—	—	45	16	19	6·9
Faith, St.	367	310	—	—	42	9	6	4·1
Flegg, East and West	349	302	1	—	38	—	8	2·3
Forehoe	358	320	—	—	28	3	7	2·8
Freebridge Lynn	417	365	4	—	32	7	9	3·8
Guiltcross	313	265	—	—	38	1	9	3·2
Henstead	318	261	1	—	39	6	11	5·3
King's Lynn	628	534	2	—	62	7	23	4·8
Loddon and Clavering	426	376	—	—	42	4	4	1·9
Mitford and Launditch	793	708	—	—	69	12	4	2·0
Norwich	3,178	2,591	2	—	421	45	119	5·2
Smallburgh	535	461	—	—	51	3	20	4·3
Swaffham	378	323	—	—	35	5	15	5·3
Thetford	509	456	1	—	46	—	6	1·2
Walsingham	589	538	—	—	30	5	16	3·6
Wayland	341	312	—	—	22	2	5	2·1
Yarmouth, Great	1,314	1,031	1	—	180	46	56	7·8

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NORTHAMPTONSHIRE.								
Brackley	343	303	—	—	22	5	13	5·2
Brixworth	342	307	—	—	30	1	4	1·5
Daventry	395	331	1	—	50	4	9	3·3
Hardingstone	325	295	—	—	19	2	9	3·4
Kettering	1,155	779	—	—	120	18	238	22·2
Northampton	2,439	1,583	6	—	292	28	530	22·9
Oundle	396	365	1	—	22	—	8	2·0
Peterborough	1,392	1,239	—	—	117	2	34	2·6
Potterspury	360	294	—	—	45	10	11	5·8
Thrapston	456	373	—	—	49	5	29	7·5
Towcester	353	302	—	—	44	4	3	2·0
Wellingborough	1,349	1,040	1	—	168	37	103	10·4
NORTHUMBERLAND.								
Alnwick	696	578	—	—	72	30	16	6·6
Belford	137	125	—	—	12	—	—	0·0
Bellingham	120	107	—	—	9	—	4	3·3
Berwick-on-Tweed	648	583	—	—	49	7	9	2·5
Castle Ward	675	582	—	—	57	4	32	5·3
Glendale	288	266	1	—	17	3	1	1·4
Haltwhistle	236	209	—	—	20	5	2	3·0
Hexham	1,025	896	—	—	92	12	25	3·6
Morpeth	1,508	1,234	—	—	224	13	37	3·3
Newcastle-on-Tyne	6,498	5,752	23	—	631	53	39	1·4
Rothbury	174	152	—	—	16	2	4	3·5
Tynemouth	4,471	3,689	7	—	510	116	149	5·9
NOTTINGHAMSHIRE.								
Basford	5,570	4,724	10	—	632	22	182	3·7
Bingham	418	362	4	—	33	8	11	4·5
East Retford	664	599	—	—	50	—	15	2·3
Mansfield	1,882	1,537	1	—	244	7	93	5·3
Newark	914	812	1	—	79	7	15	2·4
Nottingham	6,458	4,803	10	—	774	170	701	13·5
Southwell	537	470	—	—	41	6	20	4·8
Worksop	1,055	934	1	—	100	8	12	1·9
OXFORDSHIRE.								
Banbury	891	591	—	—	85	18	197	24·1
Bicester	463	416	—	—	30	2	15	3·7
Chipping Norton	553	494	1	—	35	14	9	4·2
Headington	948	844	—	—	88	5	11	1·7
Henley	668	568	1	—	61	12	26	5·7
Oxford	657	551	—	—	80	7	19	4·0
Thame	390	342	—	—	34	9	5	3·6
Witney	682	610	—	—	55	10	7	2·5
Woodstock	363	313	—	—	38	—	12	3·3
RUTLAND.								
Oakham	308	258	—	—	37	2	11	4·2
Uppingham	325	284	1	—	23	2	15	5·2

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SALOP.								
Atcham	1,436	1,206	—	—	143	32	55	6·1
Bridgnorth	405	352	—	—	45	1	7	2·0
Church Stretton	128	118	—	—	9	—	1	0·8
Cleobury Mortimer	242	215	—	—	17	2	8	4·1
Clun	277	238	—	—	30	6	3	3·2
Drayton	396	358	1	—	29	3	5	2·0
Ellesmere	368	331	—	—	32	2	3	1·4
Ludlow	477	405	3	—	35	13	21	7·1
Madeley	771	670	—	—	76	1	24	3·2
Newport	417	367	—	—	42	—	8	1·9
Oswestry	875	783	—	—	73	5	14	2·2
Shifnal	396	353	—	—	24	4	15	4·8
Wellington	832	717	1	—	101	4	9	1·6
Wem	295	265	—	—	20	7	3	3·4
Whitchurch	331	298	—	—	26	—	7	2·1
SOMERSET.								
Axbridge	1,121	961	1	—	94	20	45	5·8
Bath	1,800	1,385	3	—	178	85	149	13·0
Bedminster	2,472	2,116	7	—	265	29	55	3·4
Bridgwater	1,004	895	1	—	80	11	17	2·8
Chard	807	690	—	—	75	18	24	5·2
Clutton	802	706	1	—	74	4	17	2·6
Dulverton	160	151	—	—	7	—	2	1·3
Frome	651	578	—	—	46	8	19	4·1
Keynsham	919	769	1	—	80	19	50	7·5
Langport	434	391	—	—	32	3	8	2·5
Shepton Mallet	445	397	—	—	35	2	11	2·9
Taunton	1,051	900	4	—	88	24	35	5·6
Wellington	580	522	1	—	45	9	3	2·1
Wells	750	662	1	—	64	4	19	3·1
Williton	492	445	—	—	37	5	5	2·0
Wincanton	565	504	—	—	44	3	14	3·0
Yeovil	827	722	—	—	60	19	26	5·4
SOUTHAMPTON.								
Alresford	202	182	—	—	14	2	4	3·0
Alton	408	368	—	—	28	—	12	2·9
Alverstoke	756	684	1	—	66	—	5	0·7
Andover	463	393	—	—	33	11	26	8·0
Basingstoke	619	516	2	—	43	20	38	9·4
Catherington	86	75	—	—	5	4	2	7·0
Christchurch	1,242	1,010	3	—	119	38	72	8·9
Droxford	332	288	—	—	25	7	12	5·7
Fareham	535	466	—	—	53	1	15	3·0
Fordingbridge	185	168	—	—	11	—	6	3·2
Hartley Wintney	595	516	1	—	47	4	24	4·7
Havant	254	222	—	—	26	2	4	2·4
Hursley	59	56	—	—	1	—	2	3·4
Kingsclere	263	235	—	—	24	2	2	1·5
Lymington	384	322	1	—	41	2	18	5·2
New Forest	391	342	—	—	22	12	15	6·9
Petersfield	334	296	1	—	25	5	7	3·6
Portsea Island	4,936	4,383	4	—	455	25	69	1·9
Ringwood	154	134	—	—	15	1	4	3·2
Romsey	300	278	—	—	15	2	5	2·3
Southampton	1,673	1,355	2	—	187	38	91	7·7
South Stoneham	1,465	1,263	2	—	102	19	79	6·7
Stockbridge	178	165	—	—	5	4	4	4·5
Whitchurch	190	168	1	—	15	3	3	3·2
Wight, Isle of	2,057	1,805	12	—	126	44	70	5·5
Winchester, New	857	765	—	—	72	3	17	2·3

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STAFFORD.								
Burton-on-Trent	2,842	2,378	2	—	237	54	171	7·9
Cannock	1,480	1,291	1	—	146	1	41	2·8
Cheadle	821	719	—	—	73	7	22	3·5
Leek	1,038	888	—	—	118	7	25	3·1
Lichfield	1,341	1,214	3	—	100	5	19	1·8
Newcastle-under-Lyme	1,268	1,104	1	—	111	5	47	4·1
Seisdon	500	444	1	—	39	2	14	3·2
Stafford	985	855	—	—	80	8	42	5·1
Stoke-upon-Trent	4,370	3,553	4	—	588	28	197	5·1
Stone	1,005	863	2	—	108	8	24	3·2
Tamworth	726	623	1	—	67	7	28	4·8
Uttoxeter	428	376	3	—	44	2	3	1·1
Walsall	3,554	2,636	5	1	403	24	485	14·3
West Bromwich	4,997	4,335	10	—	496	41	115	3·1
Wolstanton and Burslem	3,039	2,641	2	—	358	17	21	1·3
Wolverhampton	4,929	4,219	4	—	556	15	135	3·0
SUFFOLK.								
Blything	814	709	1	—	62	7	35	5·2
Bosmere and Claydon	449	378	—	—	42	7	22	6·5
Bury St. Edmunds	498	437	—	—	41	6	14	4·0
Cosford	515	462	1	—	43	6	3	1·7
Hartismere	480	432	—	—	34	6	8	2·9
Hoxne	359	314	—	—	31	3	11	3·9
Ipswich	1,841	1,451	3	—	201	86	100	10·1
Mildenhall	254	228	—	—	19	2	5	2·8
Mutford and Lothingland	1,616	1,409	2	—	174	11	20	1·9
Plomesgate	570	513	—	—	37	9	11	3·5
Risbridge	578	509	1	—	55	5	8	2·2
Samford	338	295	1	—	30	2	10	3·6
Stow	619	555	—	—	57	3	4	1·1
Sudbury	858	733	—	—	94	7	24	3·6
Thingoe	484	437	3	—	31	7	6	2·7
Wangford	477	436	—	—	34	5	2	1·5
Woodbridge	705	628	1	—	51	10	15	3·5
SURREY (Extra-Metropolitan).								
Chertsey	888	760	3	—	57	25	43	7·7
Croydon	3,925	3,275	9	—	324	18	299	8·1
Dorking	434	377	—	—	38	7	12	4·4
Epsom	1,214	998	6	—	102	64	44	8·9
Farnham	1,365	1,152	1	—	136	4	72	5·6
Godstone	459	403	1	—	32	5	18	5·0
Guildford	1,436	1,279	2	—	119	8	28	2·5
Hambledon	504	469	1	—	28	—	6	1·2
Kingston	2,691	2,371	7	—	242	36	35	2·6
Reigate	923	844	1	—	51	16	11	2·9
Richmond	1,070	973	—	—	82	—	15	1·4
SUSSEX.								
Battle	509	446	5	—	49	4	5	1·8
Brighton	2,625	2,283	3	—	235	17	87	4·0
Chailey	248	224	1	—	17	4	2	2·4
Chichester	221	187	1	—	20	5	8	5·9
Cuckfield	597	532	1	—	34	7	23	5·0
Eastbourne	1,098	726	—	—	111	22	239	23·8
East Grinstead	542	473	—	—	43	8	18	4·8
East Preston	772	683	—	—	65	16	8	3·1

—	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
SUSSEX—*cont.*								
Hailsham	454	396	—	—	36	4	18	4·8
Hastings	1,421	1,156	3	—	137	44	81	8·8
Horsham	730	640	2	—	64	4	20	3·3
Lewes	312	263	1	—	16	5	27	10·3
Midhurst	419	381	—	—	27	9	2	2·6
Newhaven	293	230	—	—	36	14	13	9·2
Petworth	283	262	—	—	14	5	2	2·5
Rye	366	332	—	—	26	5	3	2·2
Steyning	1,483	1,500	2	—	132	9	40	3·3
Thakeham	220	205	—	—	9	4	2	2·7
Ticehurst	501	451	—	—	34	1	15	3·2
Uckfield	712	633	—	—	39	15	25	5·6
Westbourne	208	183	—	—	18	3	4	3·4
West Firle	66	56	—	—	3	4	3	10·6
Westhampnett	598	515	—	—	55	4	24	4·7
WARWICK.								
Alcester	581	522	—	—	43	8	8	2·8
Aston	8,310	6,737	10	—	928	88	547	7·6
Atherstone	540	464	1	—	53	6	16	4·1
Birmingham	8,544	7,181	18	—	954	46	345	4·6
Coventry	1,477	1,273	1	—	166	22	15	2·5
Foleshill	645	544	—	—	63	2	36	5·9
Meriden	285	250	—	—	25	2	8	3·5
Nuneaton	490	409	—	—	63	3	15	3·7
Rugby	869	766	—	—	63	3	37	4·6
Solihull	677	578	2	—	54	7	36	6·4
Southam	293	255	—	—	26	1	11	4·1
Stratford-on-Avon	639	548	—	—	48	2	41	6·7
Warwick	1,509	1,346	1	—	108	13	41	3·6
WESTMORELAND.								
East Ward	395	350	—	—	37	3	5	2·0
Kendal	1,222	1,120	3	—	73	16	10	2·1
West Ward	233	218	—	—	13	1	1	0·9
WILTS.								
Alderbury	810	691	1	—	78	23	17	4·9
Amesbury	198	175	—	—	20	1	2	1·5
Bradford	310	277	—	—	26	1	6	2·3
Calne	224	197	2	—	10	14	1	6·7
Chippenham	672	598	2	—	43	27	2	4·3
Cricklade and Wootton Bassett.	353	325	—	—	26	1	1	0·6
Devizes	550	485	2	—	38	6	19	4·5
Highworth and Swindon	1,448	1,272	2	—	111	29	34	4·4
Malmesbury	403	358	—	—	32	6	7	3·2
Marlborough	227	198	—	—	25	1	3	1·8
Melksham	521	462	1	—	47	6	5	2·1
Mere	181	168	—	—	9	1	3	2·2
Pewsey	344	314	—	—	23	1	6	2·0
Tisbury	231	210	—	—	9	8	4	5·2
Warminster	336	294	—	—	29	3	10	3·9
Westbury and Whorwelsdown.	268	245	—	—	21	—	2	0·7
Wilton	259	237	—	—	16	1	5	2·3

App. A. No. 1.

Digest of Vaccination Officers' Returns.

	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
WORCESTER.								
Bromsgrove	1,080	921	—	—	104	11	44	5·1
Droitwich	552	480	1	—	54	4	13	3·1
Dudley	5,596	4,937	5	2	543	13	96	1·9
Evesham	436	392	—	—	31	2	11	3·0
Kidderminster	1,223	1,094	1	—	99	7	22	2·4
King's Norton	3,259	2,853	6	—	317	18	65	2·5
Martley	463	418	—	—	33	2	10	2·6
Pershore	390	350	—	—	35	1	4	1·3
Shipston-on-Stour	490	429	1	—	37	5	18	4·7
Stourbridge	3,097	2,746	—	—	285	16	50	2·1
Tenbury	226	194	—	—	19	2	11	5·8
Upton-on-Severn	538	470	2	—	46	4	16	3·7
Worcester	1,354	1,069	3	—	208	26	48	5·5
YORK, East Riding.								
Beverley	784	663	1	—	87	11	22	4·2
Bridlington	480	416	—	—	45	7	12	4·0
Driffield	627	535	1	—	68	5	18	3·7
Howden	386	344	2	—	23	4	13	4·4
Kingston-upon-Hull	2,497	1,810	7	—	342	26	312	13·5
Patrington	242	220	—	—	18	—	4	1·7
Pocklington	462	392	—	—	51	8	11	4·0
Sculcoates	4,262	3,505	9	—	484	24	240	6·2
Skirlaugh	293	253	—	—	28	1	11	4·1
York	2,540	2,091	6	—	280	28	135	6·4
YORK, North Riding.								
Aysgarth	148	132	3	—	10	1	2	2·0
Bedale	239	222	—	—	14	—	3	1·3
Easingwold	273	240	—	—	24	—	9	3·3
Guisborough	1,523	1,301	3	—	154	16	49	4·3
Helmsley Blackmoor	148	137	—	—	9	1	1	1·4
Kirkby Moorside	140	118	—	—	17	3	2	3·6
Leyburn	203	186	—	—	12	3	2	2·5
Malton	711	575	1	—	71	27	37	9·0
Middlesbrough	4,145	3,626	5	1	425	46	42	2·1
Northallerton	362	323	3	—	28	2	6	2·2
Pickering	371	315	—	—	39	5	12	4·6
Reeth	108	97	—	—	7	2	2	3·7
Richmond	393	342	—	—	33	5	13	4·6
Scarborough	1,278	990	1	—	160	27	100	9·9
Stokesley	323	296	—	—	17	3	7	3·1
Thirsk	367	322	—	—	34	3	8	3·0
Whitby	867	769	—	—	73	5	20	2·9
YORK, West Riding.								
Barnsley	3,328	2,736	3	—	384	34	171	6·2
Bramley	1,981	1,667	2	—	239	7	66	3·7
Bradford	5,944	4,722	4	—	744	13	461	8·0
Bierley, North	3,870	3,253	11	—	415	48	143	4·9
Dewsbury	4,975	2,427	5	—	678	88	1,777	37·5
Doncaster	1,930	1,635	1	—	208	52	34	4·5
Ecclesall Bierlow	3,952	3,380	7	—	408	5	152	4·0
Goole	775	696	—	—	55	7	17	3·1
Halifax	4,973	3,797	9	—	524	112	531	13·0

—	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
YORK, West Riding—*cont.*								
Hemsworth	441	398	—	—	25	1	17	4·1
Holbeck	880	746	2	—	103	16	13	3·3
Huddersfield	4,526	4,014	6	—	445	8	53	1·3
Hunslet	2,441	2,065	3	—	297	14	62	3·1
Keighley	1,924	304	2	—	237	12	1,369	71·8
Knaresborough	619	512	3	—	67	3	34	6·0
Leeds	6,869	6,167	7	—	552	16	127	2·1
Ouseburn, Great	366	331	—	—	26	3	6	2·5
Pateley Bridge	241	223	—	—	16	1	1	0·8
Penistone	567	498	—	—	57	7	5	2·1
Pontefract	2,077	1,733	2	—	238	12	92	5·0
Ripon	464	360	—	—	51	34	19	11·4
Rotherham	3,175	2,713	7	—	330	3	122	3·9
Saddleworth	667	599	2	—	39	3	24	4·0
Sedbergh	110	93	1	—	13	3	—	2·7
Selby	469	420	1	—	38	3	7	2·1
Settle	443	400	—	—	28	7	8	3·4
Sheffield	7,212	6,178	11	2	779	18	224	3·4
Skipton	1,175	955	2	—	115	46	57	8·8
Tadcaster	879	759	—	—	84	6	30	4·1
Thorne	465	374	—	—	60	8	23	6·7
Wakefield	3,582	3,085	5	—	354	26	112	3·9
Wetherby	403	329	1	—	43	5	25	7·4
Wharfedale	1,392	1,176	—	—	132	12	72	6·0
Wortley	1,322	1,153	2	—	120	1	46	3·6
ANGLESEY.								
Anglesey	393	356	—	—	28	3	6	2·3
Holyhead	553	470	1	—	61	5	16	3·8
BRECKNOCK.								
Brecknock	423	375	—	—	38	2	8	2·4
Builth	232	205	—	—	20	3	4	3·0
Crickhowell	644	564	1	—	61	8	10	2·8
Hay	288	244	—	—	32	6	6	4·2
CARDIGAN								
Aberayron	315	272	—	—	32	6	5	3·5
Aberystwith	517	466	—	—	35	2	14	3·1
Cardigan	451	392	—	—	47	5	7	2·7
Lampeter	260	230	—	—	24	4	2	2·3
Tregaron	228	203	—	—	22	—	3	1·3
CARMARTHEN.								
Carmarthen	983	904	1	—	65	6	7	1·3
Llanelly	1,795	1,594	—	—	165	20	16	2·0
Llandilofawr	562	493	—	—	57	2	10	2·1
Llandovery	308	266	—	—	34	6	2	2·6
Newcastle-in-Emlyn	536	483	—	—	47	3	3	1·1

App. A. No. 1.

Digest of Vaccination Officers' Returns.

	Returns, 1886.							
	Births.	Successfully Vaccinated.	Insusceptible of Vaccination.	Had Small-pox.	Died unvaccinated.	Vaccination postponed.	Remaining.	Children not finally accounted for (including cases postponed), per cent. of births.
CARNARVON.								
Bangor and Beaumaris	1,009	899	1	—	88	10	11	2·1
Carnarvon	1,191	1,027	1	—	132	14	17	2·6
Conway	552	498	—	—	39	5	10	2·7
Pwllheli	569	481	1	—	65	3	19	3·9
DENBIGH.								
Llanrwst	364	303	—	—	41	19	1	5·5
Ruthin	321	286	1	—	31	3	—	0·9
Wrexham	1,889	1,657	3	—	167	26	36	3·3
FLINT.								
Asaph, St.	747	652	—	—	69	4	22	3·5
Hawarden	485	432	—	—	42	2	9	2·3
Holywell	1,184	1,030	—	—	94	22	38	5·1
GLAMORGAN.								
Bridgend and Cowbridge	1,451	1,249	—	—	148	21	33	3·7
Cardiff	5,414	4,530	8	—	566	36	274	5·7
Gower	312	261	—	—	38	7	6	4·2
Merthyr Tydfil	3,875	3,401	1	—	380	14	79	2·4
Neath	1,988	1,781	1	—	172	8	26	1·7
Pontardawe	701	622	—	—	71	2	6	1·1
Pontypridd	4,783	4,004	3	—	581	63	132	4·1
Swansea	3,933	3,518	1	—	350	10	54	1·6
MERIONETH.								
Bala	169	147	1	—	18	2	1	1·8
Corwen	442	380	—	—	36	9	17	5·9
Dolgelley	399	340	—	—	49	8	2	2·5
Festiniog	888	748	—	—	105	23	12	3·9
MONTGOMERY.								
Llanfyllin	596	525	—	—	53	11	7	3·0
Machynlleth	319	282	—	—	33	3	1	1·3
Forden	461	417	—	—	27	8	9	3·7
Newtown and Llanidloes	643	559	—	—	52	15	17	5·0
PEMBROKE.								
Haverfordwest	949	801	—	—	83	37	28	6·8
Narberth	547	475	—	—	48	11	13	4·4
Pembroke	1,010	857	1	—	108	31	13	4·4
RADNOR.								
Knighton	347	287	1	—	38	5	16	0·1
Rhayader	175	152	—	—	16	—	7	4·0

No. 2.

List (alphabetically arranged) of 293 Unions inspected during the Year 1888, with reference to the Proceedings under the Vaccination Acts, 1867 and 1871, and an Account of the Awards made to the respective Public Vaccinators out of Moneys voted by Parliament for that Purpose.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union.		Total Sum awarded in each Union.	Inspector.
			Minimum.	Maximum.		
			£ s. d.	£ s. d.	£ s. d.	
Abergavenny - -	3	2	6 3 0	10 0 0	16 3 0	Mr. Spear.
Abingdon - - -	6	5	5 4 0	16 9 0	43 4 0	Dr. Stevens.
Alderbury - - -	5	3	2 12 0	34 7 0	40 13 0	„ Blaxall.
Alnwick - - -	7	5	1 19 0	16 2 0	36 1 0	„ Page.
Alresford - - -	2	1	—	—	7 17 0	„ Stevens.
Alton - - -	4	4	5 18 0	9 18 0	31 15 0	Do.
Alverstoke - -	1	1	—	—	48 0 0	Do.
Amesbury - - -	2	1	—	—	5 6 0	„ Blaxall.
Ampthill - - -	4	4	4 3 0	11 12 0	26 1 0	„ BruceLow.
Andover - - -	5	5	1 13 0	12 10 0	31 16 0	„ Stevens.
Ashbourne - -	7	6	2 10 0	22 17 0	56 19 0	„ BruceLow.
Ashby-de-la-Zouch -	6	5	7 18 0	20 19 0	61 8 0	„ Parsons.
Ashton-under-Lyne -	9	8	5 0 0	41 16 0	181 18 0	„ Page.
Atcham - - -	7	5	4 13 0	40 1 0	61 10 0	„ Parsons.
Auckland - - -	9	6	7 12 0	25 19 0	102 6 0	„ Page.
Austell, St. - -	7	3	10 17 0	32 7 0	59 13 0	„ Ballard.
Aylesbury - - -	7	6	4 7 0	20 1 0	57 3 0	„ Parsons.
Bakewell - - -	8	8	2 13 0	18 5 0	76 5 0	Dr. BruceLow.
Banbury - - -	7	2	7 17 0	15 4 0	23 1 0	„ Blaxall.
Barrow-on-Soar - -	5	2	5 19 0	8 8 0	14 7 0	„ Parsons.
Barton-upon-Irwell -	6	5	3 10 0	40 2 0	74 5 0	„ Page.
Basingstoke - -	6	6	0 17 0	16 18 0	39 16 0	„ Stevens.
Beaminster - -	5	2	4 1 0	9 15 0	13 16 0	„ Blaxall.
Bedford - - -	8	7	4 1 0	50 12 0	131 0 0	„ BruceLow.
Bedwelty - - -	6	6	3 8 0	43 6 0	140 8 0	Mr. Spear.
Belford - - -	2	2	4 0 0	5 11 0	9 11 0	Dr. Page.

App. A. No. 2.

Inspection of Public Vaccination.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Bellingham - -	6	2	1 14 0	2 2 0	3 16 0	Dr. Page.
Belper - - -	9	8	4 6 0	49 14 0	182 15 0	„ BruceLow.
Berwick-on-Tweed -	3	2	7 5 0	11 9 0	18 14 0	„ Page.
Bicester - - -	7	3	1 11 0	4 10 0	9 16 0	„ Blaxall.
Biggleswade - -	6	6	3 15 0	14 19 0	48 13 0	„ BruceLow.
Billesdon - - -	3	—	—	—	—	„ Parsons.
Birmingham - -	1	1	—	—	199 1 0	„ Stevens.
Blaby - - -	3	—	—	—	—	„ Parsons.
Blackburn - -	10	5	9 12 0	42 14 0	128 9 0	„ Page.
Blandford - - -	4	4	4 3 0	14 1 0	30 9 0	„ Blaxall.
Bodmin - - -	7	4	1 14 0	8 16 0	20 1 0	„ Ballard.
Bolton - - -	9	9	3 1 0	100 2 0	264 16 0	„ Page.
Bourn - - -	7	3	2 13 0	5 0 0	11 6 0	„ BruceLow.
Brackley - - -	4	2	7 10 0	8 7 0	15 17 0	„ Parsons.
Bradfield - - -	5	5	5 11 0	11 19 0	42 11 0	„ Stevens.
Brentford - - -	9	4	24 11 0	45 2 0	134 10 0	Mr. Power.
Bridgnorth - -	3	2	4 2 0	8 1 0	12 3 0	Dr. Parsons.
Bridport - - -	4	3	5 9 0	24 14 0	37 7 0	„ Blaxall.
Brixworth - - -	5	3	3 17 0	10 7 0	18 2 0	„ Parsons.
Bromgrove - -	5	5	0 16 0	27 19 0	57 5 0	Mr. Spear.
Bromyard - - -	3	1	—	—	5 1 0	Do.
Builth - - -	1	1	—	—	9 6 0	Do.
Burnley - - -	7	4	5 0 0	42 3 0	70 13 0	Dr. Page.
Burton-on-Trent - -	8	4	6 13 0	56 4 0	111 4 0	„ Parsons.
Bury - - -	6	5	13 8 0	57 8 0	152 3 0	„ Page.
Calne - - -	1	1	—	—	18 15 0	Dr. Blaxall.
Cambridge - -	1	1	—	—	65 19 0	„ Airy.
Camelford - -	2	1	—	—	16 5 0	„ Ballard.
Cannock - - -	6	2	1 2 0	6 14 0	7 16 0	„ Parsons.
Castle Ward - -	6	4	4 4 0	22 2 0	42 3 0	„ Page.
Caxton and Arrington -	4	4	3 8 0	10 7 0	30 6 0	„ Airy.
Cerne - - -	4	1	—	—	1 3 0	„ Blaxall.
Chapel-en-le-Frith -	3	2	7 10 0	24 5 0	31 15 0	„ BruceLow.
Chard - - -	7	4	2 14 0	13 18 0	32 10 0	„ Blaxall.
Cheadle - - -	5	3	7 13 0	14 19 0	31 12 0	„ Parsons.
Chepstow - - -	5	4	7 8 0	13 3 0	40 12 0	Mr. Spear.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Chertsey - - -	5	5	4 3 0	15 9 0	43 10 0	Dr. Stevens.
Chesterfield - -	11	9	15 14 0	54 14 0	317 6 9	„ BruceLow.
Chesterton - -	7	3	8 9 0	12 4 0	29 19 0	„ Airy.
Chippenham - -	6	4	3 8 0	19 4 0	47 2 0	„ Blaxall.
Chipping Norton -	4	2	12 7 0	21 11 0	33 18 0	Do.
Chorley - - -	5	5	9 4 0	28 5 0	82 18 0	„ Page.
Christchurch (Hants) -	2	2	8 18 0	43 17 0	52 15 0	„ Stevens.
Church Stretton - -	4	1	—	—	2 3 0	„ Parsons.
Cleobury Mortimer -	2	1	—	—	9 8 0	Do.
Clitheroe - -	5	5	2 12 0	18 1 0	38 14 0	„ Page.
Clun - - -	4	2	4 5 0	6 16 0	11 1 0	„ Parsons.
Columb, St., Major -	6	5	3 16 0	13 15 0	38 15 0	„ Ballard.
Cookham - - -	4	3	2 0 0	17 8 0	34 6 0	„ Stevens.
Coventry - - -	1	1	—	—	71 5 0	Do.
Croydon - - -	6	5	4 6 0	53 8 0	107 1 0	Do.
Darlington - -	5	5	3 13 0	44 7 0	63 4 0	Dr. Page.
Daventry - - -	6	2	2 10 0	12 9 0	14 19 0	„ Parsons.
Doncaster - - -	7	5	5 12 0	52 11 0	131 12 0	„ BruceLow.
Dorchester - -	6	4	1 10 0	10 12 0	25 5 0	„ Blaxall.
Dore - - -	3	3	3 4 0	4 18 0	11 9 0	Mr. Spear.
Dorking - - -	4	4	1 15 0	8 9 0	24 17 0	Dr. Stevens.
Drayton - - -	5	3	2 14 0	11 11 0	18 9 0	„ Parsons.
Droitwich - - -	6	6	1 0 0	13 3 0	40 4 0	Mr. Spear.
Droxford - - -	4	4	4 10 0	7 2 0	24 3 0	Dr. Stevens.
Dudley - - -	8	7	22 1 0	42 6 0	220 4 0	Mr. Spear.
East Hampstead - -	4	4	3 13 0	14 1 0	28 18 0	Dr. Stevens.
Edmonton - -	13	9	0 17 0	53 13 0	184 7 0	„ BruceLow.
Ellesmere - - -	6	4	5 10 0	9 13 0	26 14 0	„ Parsons.
Ely - - - -	5	5	6 10 0	17 17 0	47 18 0	„ Airy.
Epsom - - -	9	7	2 8 0	13 12 0	49 2 0	„ Stevens.
Evesham - - -	5	4	1 1 0	15 13 0	27 16 0	Mr. Spear.
Falmouth - - -	4	1	—	—	5 5 0	Dr. Ballard.
Fareham - - -	5	1	—	—	11 8 0	„ Stevens.
Faringdon - -	4	3	4 3 0	8 3 0	16 11 0	Do.

App. A. No. 2.

Inspection of Public Vaccination.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union.		Total Sum awarded in each Union.	Inspector.
			Minimum.	Maximum.		
			£ s. d.	£ s. d.	£ s. d.	
Farnham - - -	6	6	2 15 0	64 4 0	104 16 0	Dr. Stevens.
Fordingbridge - -	2	2	8 9 0	9 0 0	17 9 0	Do.
Fulham - - -	3	3	67 8 0	87 3 0	234 4 0	Do.
Fylde, The -	5	5	4 15 0	24 7 0	76 8 0	„ Page.
Garstang - - -	3	3	5 17 0	8 0 0	21 16 0	Dr. Page.
Gateshead - -	5	3	18 9 0	141 17 0	186 10 0	Do.
Germans, St. - -	6	3	4 19 0	13 4 0	29 13 0	„ Ballard.
George, St., Hanover Square.	4	4	4 0 0	63 6 0	107 5 0	„ Stevens.
Giles, St., and St. George	1	1	—	—	32 6 0	Do.
Glendale - - -	6	3	0 14 0	4 18 0	8 18 0	„ Page.
Glossop - - -	2	1	—	—	32 13 0	„ BruceLow.
Godstone - - -	5	4	4 12 0	8 8 0	25 19 0	„ Stevens.
Grantham - -	7	5	3 5 0	20 2 0	37 18 0	„ BruceLow.
Greenwich - -	2	2	48 15 0	66 11 0	115 6 0	„ Stevens.
Guildford - -	9	9	4 4 0	18 16 0	84 13 0	Do.
Hambledon - -	5	5	5 15 0	12 11 0	44 2 0	Dr. Stevens.
Hampstead - -	1	1	—	—	23 9 0	Do.
Hardingstone - -	3	2	8 10 0	11 9 0	19 19 0	„ Parsons.
Hartismere - -	5	1	—	—	10 10 0	„ Airy.
Hartley Wintney -	6	6	1 16 0	9 6 0	37 6 0	„ Stevens.
Haslingden - -	6	6	6 16 0	46 13 0	173 11 0	„ Page.
Hayfield - - -	1	1	—	—	37 9 0	„ BruceLow.
Headington - -	2	2	13 19 0	84 4 0	98 3 0	„ Blaxall.
Helmsley - - -	2	1	—	—	2 9 0	„ Barry.
Helston - - -	5	3	11 11 0	16 15 0	41 11 0	„ Ballard.
Hemsworth - -	4	4	1 13 0	35 4 0	55 6 0	„ BruceLow.
Hendon - - -	7	5	3 11 0	79 3 0	146 18 0	Do.
Henley - - -	6	2	11 4 0	16 0 0	27 4 0	„ Blaxall.
Hereford - - -	4	3	6 1 0	35 1 0	50 4 0	Mr. Spear.
Hinckley - - -	5	5	1 19 0	18 16 0	49 17 0	Dr. Parsons.
Holbeach - - -	6	6	4 18 0	10 17 0	44 6 0	„ BruceLow.
Holborn - - -	4	4	31 11 0	61 2 0	173 10 0	„ Stevens.
Horncastle - -	6	6	4 8 0	9 19 0	41 1 0	„ BruceLow.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Hoxne - -	8	4	1 8 0	10 8 0	22 12 0	Dr. Airy.
Hungerford -	5	5	4 2 0	10 0 0	36 3 0	„ Stevens.
Hursley - -	1	1	—	—	6 8 0	Do.
Ipswich - -	1	1	—	—	86 6 0	Dr. Airy.
Kensington - -	2	2	33 3 0	100 4 0	133 7 0	Dr. Stevens.
Kettering - - -	4	3	5 4 0	32 10 0	53 9 0	„ Parsons.
Kidderminster - -	5	4	5 0 0	41 13 0	67 6 0	Mr. Spear.
Kingsclere - -	3	3	5 10 0	10 11 0	23 9 0	Dr. Stevens.
Kings Norton - -	7	4	6 2 0	50 6 0	81 18 0	Mr. Spear.
Kingston (Surrey) -	11	11	2 6 0	29 7 0	106 9 0	Dr. Stevens.
Kington - - -	5	4	2 6 0	9 0 0	22 13 0	Mr. Spear.
Kirkby Moorside - -	1	1	—	—	6 17 0	Dr. Barry.
Knighton - - -	5	1	—	—	6 14 0	Mr. Spear.
Langport - - -	6	2	1 11 0	6 8 0	7 19 0	Dr. Blaxall.
Launceston - -	8	2	6 17 0	8 11 0	15 8 0	„ Ballard.
Ledbury - - -	3	2	6 19 0	8 13 0	15 12 0	Mr. Spear.
Leeds - - -	7	7	1 4 0	45 17 0	145 13 0	Dr. Stevens.
Leek - - -	5	5	1 17 0	16 8 0	46 6 0	„ Parsons.
Leicester - - -	2	2	12 9 0	13 5 0	25 14 0	Do.
Leigh - - -	3	3	17 19 0	59 9 0	107 10 0	„ Page.
Leighton Buzzard -	2	2	2 7 0	51 16 0	54 3 0	„ BruceLow.
Leominster - -	3	2	7 7 0	17 9 0	24 16 0	Mr. Spear.
Lichfield - - -	6	4	1 12 0	24 10 0	61 5 0	Dr. Parsons.
Linton - - -	3	3	8 9 0	14 2 0	36 12 0	„ Airy.
Liskeard - - -	7	4	3 6 0	15 2 0	32 3 0	„ Ballard.
Liverpool - - -	3	3	35 19 0	64 10 0	142 9 0	„ Stevens.
Loughborough - -	4	2	16 10 0	17 1 0	33 11 0	„ Parsons.
Ludlow - - -	5	1	—	—	3 18 0	Do.
Luton - - -	6	5	3 7 0	17 3 0	34 10 0	„ BruceLow.
Lutterworth - -	6	3	3 17 0	7 14 0	16 17 0	„ Parsons.
Lymington - -	4	3	2 0 0	9 7 0	14 8 0	„ Stevens.

App. A. No. 2.

Inspection of Public Vaccination.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Madeley - - -	4	—	—	—	—	Dr. Parsons.
Manchester - -	3	3	34 0 0	62 1 0	151 0 0	„ Stevens.
Market Bosworth -	6	3	1 12 0	12 2 0	20 16 0	Dr. Parsons.
Market Harborough -	5	1	—	—	3 18 0	Do.
Martley - - -	6	6	3 8 0	8 4 0	33 9 0	Mr. Spear.
Melksham - - -	2	2	14 15 0	24 1 0	38 16 0	Dr. Blaxall.
Melton Mowbray -	6	2	5 11 0	5 17 0	11 8 0	„ Parsons.
Merthyr Tydfil - -	10	10	4 17 0	59 14 0	253 1 0	Mr. Spear.
Monmouth - -	6	4	3 10 0	20 7 0	45 15 0	Do.
Morpeth - - -	9	5	7 1 0	26 6 0	56 16 0	Dr. Page.
Newbury - - -	3	3	7 1 0	13 9 0	30 15 0	Dr. Stevens.
Newcastle-on-Tyne -	3	4	28 12 0	65 1 0	165 7 0	Do.
Newcastle-under-Lyme -	3	2	1 17 0	40 7 0	42 4 0	„ Parsons.
New Forest - -	5	5	0 14 0	16 0 0	30 11 0	„ Stevens.
Newmarket - -	8	5	5 6 0	23 9 0	59 14 0	„ Airy.
Newport (Mon.) - -	8	7	1 19 0	87 7 0	207 2 0	Mr. Spear.
Newport (Salop) - -	4	3	6 16 0	10 17 0	27 5 0	Dr. Parsons.
Newport Pagnell - -	10	2	1 0 0	7 16 0	8 16 0	Do.
Northallerton - -	4	3	2 14 0	17 2 0	24 4 0	„ BruceLow.
Northampton - -	4	1	—	—	16 6 0	„ Parsons.
North Witchford -	4	4	4 9 0	16 3 0	38 10 0	„ Airy.
Olave, St. - - -	3	3	30 6 0	105 7 0	213 2 0	Dr. Stevens.
Oldham - - -	6	6	9 12 0	26 7 0	111 6 0	„ Page.
Ormskirk - - -	7	6	8 8 0	40 12 0	141 10 0	Do.
Oswestry - - -	5	3	5 17 0	32 6 0	57 0 0	„ Parsons.
Oxford - - -	1	1	—	—	42 16 0	„ Blaxall.
Penzance - - -	5	9	3 16 0	21 15 0	52 0 0	Dr. Ballard.
Pershore - - -	5	2	6 6 0	9 8 0	15 14 0	Mr. Spear.
Petersfield - -	4	4	3 4 0	8 7 0	20 1 0	Dr. Stevens.
Pickering - - -	3	—	—	—	—	„ BruceLow.
Pontefract - -	7	7	2 14 0	44 18 0	144 9 0	Do.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Pontypool - - -	4	4	7 2 0	36 17 0	94 3 0	Mr. Spear.
Pontypridd - -	9	5	9 12 0	72 5 0	159 16 0	Do.
Poole - - -	4	2	14 14 0	20 3 0	34 17 0	Dr. Blaxall.
Poplar - - -	4	3	17 12 0	133 17 0	187 11 0	„ Stevens.
Portsea Island - -	1	1	—	—	151 13 0	Do.
Potterspury - -	4	1	—	—	25 5 0	„ Parsons.
Preston - - -	4	4	9 15 0	105 7 0	194 19 0	„ Page.
Prestwich - - -	6	5	3 13 0	112 5 0	301 12 0	Do.
Reading - - -	1	1	—	—	76 10 0	Dr. Stevens.
Redruth - - -	6	2	18 16 0	21 13 0	40 9 0	„ Ballard.
Reeth - - -	2	1	—	—	7 17 0	„ BruceLow
Reigate - - -	4	4	4 2 0	21 1 0	36 17 0	„ Stevens.
Rhayader - - -	2	1	—	—	5 12 0	Mr. Spear.
Richmond (Surrey) -	3	3	10 16 0	27 6 0	49 6 0	Dr. Stevens.
Richmond (Yorks) -	5	4	1 7 0	13 5 0	26 16 0	„ BruceLow.
Ringwood - - -	1	1	—	—	14 4 0	„ Stevens.
Rochdale - - -	6	4	3 5 0	113 12 0	150 5 0	„ Page.
Romsey - - -	5	4	0 13 0	14 7 0	22 19 0	„ Stevens.
Ross - - -	2	1	—	—	19 13 0	Mr. Spear.
Rothbury - - -	6	2	0 17 0	3 3 0	4 0 0	Dr. Page.
Salford - - -	4	3	26 18 0	73 7 0	165 11 0	Dr. Stevens.
Saviour, St. - -	5	4	33 1 0	56 12 0	173 2 0	Do.
Scarborough - -	5	4	2 6 0	24 19 0	39 19 0	„ Barry.
Seisdon - - -	4	3	5 9 0	8 1 0	20 3 0	„ Parsons.
Shardlow - - -	8	8	4 6 0	68 0 0	161 16 0	„ BruceLow.
Sheffield - - -	6	6	12 16 0	45 8 0	178 18 0	„ Stevens.
Shepton Mallet - -	5	2	1 9 0	15 17 0	17 6 0	„ Blaxall.
Sherborne - - -	3	3	8 1 0	18 11 0	35 11 0	Do.
Shifnal - - -	4	2	7 4 0	10 0 0	17 4 0	„ Parsons.
Shipston-on-Stour -	5	3	3 13 0	10 14 0	21 16 0	Mr. Spear.
Shoreditch - -	3	3	28 9 0	123 11 0	244 0 0	Dr. Stevens.
Sleaford - - -	7	3	2 17 0	6 4 0	12 7 0	„ BruceLow.

App. A. No. 2.

Inspection of Public Vaccination.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Southampton - -	2	2	49 1 0	50 11 0	99 12 0	Dr. Stevens.
South Stoneham - -	5	5	6 14 0	27 0 0	87 12 0	Do.
Spalding - - -	9	3	0 18 0	7 7 0	13 11 0	„ BruceLow.
Spilsby - - -	7	5	5 15 0	8 13 0	34 14 0	Do.
Stafford - - -	4	2	8 7 0	25 5 0	33 12 0	„ Parsons.
Staines - - -	7	3	8 8 0	16 5 0	37 3 0	„ BruceLow.
Stamford - - -	7	7	0 10 0	15 1 0	30 4 0	Do.
Stepney - - -	1	1	—	—	93 17 0	„ Stevens.
Stockbridge - -	2	2	7 3 0	7 11 0	14 14 0	Do.
Stokesley - - -	4	3	4 16 0	11 11 0	22 5 0	„ BruceLow
Stoke-upon-Trent -	5	4	9 9 0	81 10 0	167 8 0	„ Parsons.
Stone - - -	4	—	—	—	—	Do.
Stourbridge - -	7	6	5 15 0	44 8 0	154 16 0	Mr. Spear.
Strand - - -	1	1	—	—	22 13 0	Dr. Stevens.
Stratton - - -	2	2	6 8 0	13 14 0	20 2 0	„ Ballard.
Tamworth - -	3	2	19 17 0	26 5 0	46 2 0	Dr. Parsons.
Teesdale - - -	6	4	3 12 0	17 6 0	35 17 0	„ Page.
Tenbury - - -	2	2	6 10 0	8 3 0	14 13 0	Mr. Spear.
Thame - - -	6	2	0 15 0	8 17 0	9 12 0	Dr. Blaxall.
Thirsk - - -	6	6	1 6 0	15 5 0	29 12 0	„ Bruce Low.
Thorne - - -	6	4	2 1 0	4 7 0	14 0 0	Do.
Thrapston - -	5	—	—	—	—	„ Parsons.
Tisbury - - -	3	1	—	—	8 1 0	„ Blaxall.
Todmorden - -	2	2	7 3 0	22 6 0	29 9 0	„ Page.
Towcester - - -	4	1	—	—	4 1 0	„ Parsons.
Toxteth Park - -	2	2	31 19 0	47 17 0	79 16 0	„ Stevens.
Truro - - -	7	4	3 11 0	16 14 0	31 11 0	„ Ballard.
Upton-on-Severn -	5	5	1 3 0	15 5 0	39 10 0	Mr. Spear.
Uttoxeter - - -	5	1	—	—	4 16 0	Dr. Parsons.
Uxbridge - - -	7	6	5 1 0	27 2 0	89 0 0	„ Bruce Low.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union. Minimum.	Range of Awards in each Union. Maximum.	Total Sum awarded in each Union.	Inspector.
			£ s. d.	£ s. d.	£ s. d.	
Wakefield - - -	6	5	16 17 0	108 12 0	305 1 0	Dr. Bruce Low.
Wallingford - -	3	3	8 1 0	11 18 0	28 4 0	„ Stevens.
Walsall - - -	4	4	14 5 0	55 5 0	134 16 0	„ Parsons.
Wantage - - -	6	3	4 3 0	8 2 0	17 1 0	„ Stevens.
Wareham and Purbeck -	7	1	—	—	8 13 0	„ Blaxall.
Warminster - -	5	4	3 10 0	13 1 0	26 19 0	Do.
Warrington - -	3	3	7 10 0	115 4 0	161 13 0	„ Page.
Weardale - - -	5	4	1 7 0	14 3 0	27 14 0	Do.
Wellingborough - -	5	4	8 17 0	46 1 0	81 16 0	„ Parsons.
Wellington (Salop) -	3	2	29 10 0	31 14 0	61 4 0	Do.
Wem - - -	4	2	3 19 0	8 11 0	12 10 0	Do.
Weobley - - -	3	1	—	—	5 4 0	Mr. Spear.
West Bromwich - -	5	4	22 11 0	56 7 0	178 9 0	Dr. Parsons.
Westbury and Whorwelsdown.	4	4	2 10 0	13 1 0	23 12 0	„ Blaxall.
West Derby - -	7	7	15 2 0	101 1 0	303 18 0	Dr. Stevens.
West Ham - -	9	7	22 0 0	88 12 0	466 12 0	„ Airy.
Westminster - -	1	1	—	—	14 18 0	„ Stevens.
Weymouth - -	6	4	4 7 0	25 14 0	47 18 0	„ Blaxall.
Whitby - - -	4	2	8 12 0	10 16 0	19 8 0	„ Barry.
Whitechapel - -	1	1	—	—	163 0 0	„ Stevens.
Whitchurch (Hants) -	3	3	1 17 0	8 0 0	14 16 0	Do.
Whitchurch (Salop) -	4	4	0 14 0	14 10 0	25 17 0	„ Parsons.
Whittlesey - -	2	1	—	—	6 16 0	„ Airy.
Wigan - - -	9	7	7 3 0	60 12 0	278 12 0	„ Page.
Wight, Isle of - -	9	9	2 0 0	22 6 0	98 10 0	„ Stevens.
Wilton - - -	4	1	—	—	5 3 0	„ Blaxall.
Wimborne and Cranborne.	4	2	15 12 0	22 13 0	38 5 0	Do.
Wincanton - -	6	3	3 19 0	9 12 0	20 15 0	Do.
Winchester, New -	4	3	5 11 0	32 14 0	46 6 0	„ Stevens.
Windsor - - -	3	3	8 7 0	30 8 0	57 12 0	Do.
Wisbech - - -	14	7	2 11 0	22 8 0	56 18 0	„ Airy.
Witney - - -	4	1	—	—	20 7 0	„ Blaxall.
Woburn - - -	3	2	8 6 0	14 17 0	23 3 0	„ Bruce Low.
Wokingham - -	4	4	8 0 0	15 7 0	43 6 0	„ Stevens.
Wolstanton and Burslem	3	2	47 4 0	47 17 0	95 1 0	„ Parsons.
Wolverhampton - -	4	1	—	—	27 14 0	Do.

App. A. No. 2.

Inspection of Public Vaccination.

UNION.	No. of Vaccination Districts in the Union.	No. of Public Vaccinators recommended for Award.	Range of Awards in each Union.		Total Sum awarded in each Union.	Inspector.
			Minimum.	Maximum.		
			£ s. d.	£ s. d.	£ s. d.	
Woodbridge - -	4	4	10 9 0	15 3 0	51 4 0	Dr. Airy.
Woodstock - -	5	2	3 6 0	7 4 0	10 10 0	„ Blaxall.
Worcester - - -	1	1	—	—	50 0 0	Mr. Spear.
Yeovil - - -	7	4	5 16 0	18 9 0	41 9 0	Dr. Blaxall.
Total - -	1,410	998	—	—	17,974 1 0	

No. 3.

Statistics of the National Vaccine Establishment and Educational Vaccination Stations.

I.—Staff at end of 1888.

N.B.—The Stations named in *italics* are Educational Vaccination Stations authorised by the Local Government Board.

Description of Vaccinators.	Name of Vaccinator.	Vaccination Stations.	Days and Hours of Attendance.
Vaccinators supplying lymph for the public service, & salaried from the Parliamentary grant.	1. Dr. R Cory	*Surrey Chapel*	Tues., Thurs.; 2.
	2. Mr. W. E. G. Pearse	*Tottenham Court Chapel.*	Mon., Wednes.; 1.
Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment.	1. Mr. Ellis S. Guest	*Manchester*	Monday; 2.
	2–6. Dr. Edmund Robinson.	*Birmingham*	Monday, Tuesday, Wednesday } 11.; Wednesday; 2.; Thursday; 11.
	7. Mr. Roger Parker	*Liverpool*	Tuesday; 2.30.
	8. Mr. E. L. Webb	*Pimlico*	Thursday; 10.
	9. Mr. J. Hawthorn	*Newcastle-on-Tyne.*	Wednesday; 3.
	10. Mr. W. E. G. Pearse	*Westminster*	Tuesday; 10.
	11–12. Mr. W. A. Sumner	*Marylebone*	Tuesday; 2.; Wednesday; 10.
	13. Mr. Frederick Holmes	*Leeds*	Tuesday; 2.30.
	14. Dr. Edward Lynes	Coventry	Tuesday; 12.
	15–16. Dr. Hugh Thomson	*Glasgow*	Monday; 2.; Mon., Thurs.; 12.
	17. Mr. W. Skinner	*Sheffield*	Tuesday; 3.
	18. Dr. A. C. Clarke	Salford	Thursday; 2.
	19. Dr. G. A. Miskin	Waterloo	Tuesday; 2.
	20. Dr. J. B. Buist	*Edinburgh*	Thursday; 3.
	21. Dr. R. Cory	*St. Thomas's Hosp.*	Wednesday; 11.30.
	22. Dr. D. C. McVail	*Glasgow West*	Monday; 1.
Teachers of Vaccination not supplying lymph.	Dr. W. Husband	*Edinburgh*	Wednes., Sat.: 12.
	Mr. H. Lawrence	*Bristol*	Wednesday; 10.
	Mr. William A. Budd	*Exeter*	Thursday; 3.
	Mr. V. A. Jaynes	*Horsleydown*	Wednesday; 3.
	Dr. A. N. Montgomery	*Dublin*	Tues., Fri.; 10.
	Dr. R. Cory.	*Cambridge*	Friday; 11.

App. A. No. 3.

National Vaccine Establishment.

II.—Animal Vaccine Station.

The Animal Vaccine Station is at 95, Lamb's Conduit Street, where the Director (Dr. R. Cory) and the Assistant Director attend for the Vaccination of Children on Tuesdays and Thursdays, at 10.30 a.m.

III.—Sources and Amount of Lymph Supply in 1888.

N.B.—The Stations named in *italics* are Educational Vaccination Stations authorised by the Local Government Board.

Description of Vaccinators.	Vaccination Stations.	Number of Vaccinations performed at the Stations respectively.		Number of Charges of Lymph supplied from the Stations respectively.	
		Primary.	Re-vaccinations.	Charged Ivory Points.	Charged Tubes each estimated as equal to 10 Ivory Points.
Vaccinators salaried from the Parliamentary grant.	1. *Surrey Chapel*	213	27	1,172	—
	2. *Tottenham Court Chapel.*	472	8	—	208
	Total -	685	35	1,172	208
Parochial and other Vaccinators not salaried from the Parliamentary grant, but contributing lymph at a fixed rate of payment.	1. *Manchester** -	—	—	—	—
	2–6. *Birmingham* -	4,383	132	—	1,034
	7. *Liverpool* -	1,266	10	—	164
	8. *Pimlico* - -	334	14	—	—
	9. *Newcastle-on-Tyne.*	612	50	—	342
	10. *Westminster* -	596	22	—	264
	11–12. *Marylebone*	824	69	—	—
	13. *Leeds* - -	857	1	—	—
	14. Coventry -	818	4	—	1,062
	15–16. *Glasgow* -	1,802	1	—	498
	17. *Sheffield* - -	1,186	1,774	—	—
	18. Salford - -	799	64	—	282
	19. Waterloo -	889	4	—	1,753
	20. *Edinburgh* -	304	4	—	—
	21. *St. Thomas's Hospital.*	338	11	—	28
	22. *Glasgow West*	623	—	—	23
	Total -	15,631	2,160	—	5,450
	Grand Total	16,316	2,195	1,172	5,658

* No information received from this station

III.—Sources and Amount of Lymph—*continued.*

During the year, additional supplies (to the extent of 2,841 charged points and 9,655 charged tubes) were obtained from the following gentlemen:—

Mr. W. H. Kempster, Battersea East.
Mr. J. P. Purvis, Greenwich.
Dr. N. E. Roberts, Toxteth Park.
Dr. T. N. Orchard, Pendleton.
Dr. T. M. Johnson, Salford.
Mr. J. W. Kay, St. George's East.
Mr. J. Bark, Kirkdale.
Dr. P. Kavanagh, Deptford.
Dr. R. S. Archer, Everton.
Dr. F. Cadell, Edinburgh.
Mr. A. Meeson, Toxteth Park.
Mr. T. Price, Manchester.
Mr. A. Blackmore, Manchester.
Dr. R. F. Cook, Gateshead.
Dr. E. Goddard, Clerkenwell.
Dr. R. Hibberd, Paddington.
Dr. T. Leonard, Hoxton.
Mr. A. Matcham, Southwark.
Dr. G. A. Miskin, Kennington.
Mr. E. H. Moore, Bethnal Green.
Mr. J. C. Roberts, Peckham.
Mr. W. G. Rowntree, Liverpool Road.
Mr. G. W. Collins, Lamb's Conduit Street.

IV.—Distribution of Human Lymph, 1888.

Number of applications:

From Medical Practitioners in England and Wales -	6,648
„ „ „ Scotland - - -	223
„ the Army - - - - - -	43
„ the Navy and from the Emigration Department -	48
„ India and the Colonies - - - -	111
„ Diplomatic and other Foreign Services - -	38
Total - -	7,111

Supplies sent out:—

Charged ivory points - - - - -	3,991
„ capillary tubes - - - - -	14,074

App. A. No. 3.

V.—Distribution of Calf-Lymph, 1888.

National Vaccine Establishment.

Number of applications	3,094
Supplies received:—	
Charged ivory points	21,155
„ capillary tubes	107
Supplies sent out:—	
Charged ivory points	21,485
„ capillary tubes	107

No. 4.

REPORT on the OPERATIONS of the ANIMAL VACCINE STATION at LAMB'S CONDUIT STREET, during the Year 1888–89; by Dr. Cory.

DURING the year 1st April 1888 to 31st March 1889, 295 calves were received at Lamb's Conduit Street. Of these, 282 (males 193, females 89), were vaccinated for the purposes of the station, other 13 were discarded.

The aggregate weight, on reception at Lamb's Conduit Street, of the 282 calves was, males 50,055 lbs., females 22,785 lbs. On dismissal from the station their weights were respectively 53,567 and 24,570 lbs., so that during retention for vaccination purposes calves of both sexes gained considerably in weight; males by an average 18·2 lbs., females by an average of 20 lbs.

Of the above calves, 261 were vaccinated with lymph directly derived from other calves, and 21 were vaccinated with calf-lymph which had been stored. As usual, vaccinations performed with stored lymph proved much less successful than the others, 1,110 insertions of stored lymph producing no more than 695 vesicles, whereas 17,795 insertions in 259* calf-to-calf operations produced 17,028 vesicles; rates of insertion success respectively of 62·6 and 95·7 per cent. No difference in the result of calf-to-calf vaccinations was observed whether the lymph used was from calves vaccinated 96 or from calves vaccinated 120 hours previously; in both cases (98 calves in the one, 161 in the other), the rate of insertion success was the same, namely, 95·7 per cent.

Primary Vaccinations.—During the year 1888–89, 7,048 persons received primary vaccination at the station, five separate insertions of lymph being made in each instance. 3,554 of these persons were males and 3,494 females. All but 20 of the 7,048 primary vaccinations succeeded at the first attempt, and in no case was a third attempt at vaccination requisite. The amount of insertion success obtained by each of three several operators was as follows:—

Of 374 persons primarily vaccinated by Mr. Murphy three failed to return for inspection. The remaining 371 were on examination found to have taken all of them in five places, an insertion success of 100 per cent.

Of 729 persons primarily vaccinated by Mr. Stott (acting for Mr. Murphy or myself in the absence of one or other of us), eight failed to return for inspection. Of the remaining 721, 629 were found to have taken in five places, 53 in four, 22 in three, 7 in two, and 9 in one place only, while in a single instance the vaccination was unsuccessful at first trial. Mr. Stott's insertion success rate therefore was 95·6 per cent.

Of 5,945 persons primarily vaccinated by myself, 77 who failed to return for inspection, and other 17 (13 of them operated on for cure of nævi) are not taken into account in these statistics. Of the 5,851 remaining, 5,344 were found to have taken in five places, 277 in four,

* Two calf-to-calf vaccinations are here omitted from consideration; one for the reason that on first attempt at vaccination of the calf all insertions failed completely, and the other because the amount of success obtained was by oversight left unrecorded.

107 in three, 66 in two, and 38 in one place only, while in 19 cases vaccination proved unsuccessful on first trial, an insertion success rate of 96·8 per cent.

Re-vaccinations.—These during the year numbered 208. Mr. Murphy performed 14, Mr. Stott 10, and I, myself, 184. The insertion success rate obtained among those (201) which returned for inspection was, by Mr. Murphy and Mr. Stott each 100 per cent., by myself, 95·2 per cent.

No. 5.

Introduction to Dr. Barry's Report on Small-pox at Sheffield, 1887–88; by the Medical Officer.

Introduction to Dr. Barry's Report on Small-pox at Sheffield, 1887–88, addressed by the Medical Officer to the President of the Local Government Board. (March 1889.)

Occasion of inquiry.

An epidemic of small-pox in Sheffield during the second half of the year 1887, at the time when the disease was at an unprecedentedly low ebb in England and Wales generally, has furnished your Medical Department with an opportunity of investigating the behaviour of small-pox under comparatively simple conditions and in a community large enough to reward a particularly careful statistical study. Dr. Barry, the Departmental Inspector to whom this investigation was entrusted, commenced his inquiries in January 1888, at a time when upwards of 300 new cases were occurring each week in the borough; and he continued his observations uninterruptedly until the end of June. The report, however, has reference only to cases occurring up to March 31st, when the weekly number of attacks had fallen below 100.

Course of inspection.

In the first instance Dr. Barry's attention was principally given to concerting with the local authorities, who were already taking measures for vaccination and revaccination, and for obtaining ampler and more secure isolation arrangements, such further procedure as could be devised for the repression of the existing epidemic, and these he had the satisfaction of seeing carried out with energy and despatch. Particularly deserving of mention is a house-to-house visitation of the borough, made in a very thorough manner by the vaccination officers and their assistants in the Sheffield and Ecclesall Unions, and resulting in the discovery of cases of small-pox and of neglected vaccination, that would not otherwise have come to light. This "vaccination census," as it was termed, had reference to a population of 275,878 persons, out of a total population estimated at 316,288; and to a number of houses no less than 59,807, the number of houses in the borough, enumerated in 1881 having been 57,330. It was utilised for the purpose of learning the age of each individual, the facts as to each person's date of vaccination, and the facts about each person who had at any time suffered from small-pox. Dr. Barry's inquiry had, for departmental reasons, to be closed on March 31st, 1888, before the epidemic was at an end; and his history of the epidemic does not include the cases, nor the 90 deaths, that occurred during the subsequent quarters of the year. It records, however, all that was of importance until the decline of the epidemic, and takes account of 6,088 small-pox cases, and 590 small-pox deaths.* His report will be found to proceed in great measure upon data obtained in the house-to-house

"Census."

[p. 169.]

* A few supplementary data contributed by Dr. Thomson, Medical Officer of Health, and relating to the three subsequent quarters of 1888, are placed at the foot of pages 192 and 257 of Dr. Barry's report. They are mere extensions of certain experiences recorded in the report.

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visitation; and it comprises an abundance of other information amassed by the Sanitary Authority of Sheffield for his purposes as well as for their own use, and derived from medical practitioners and other inhabitants of the borough, who placed their services very freely at the disposal of the Health Office. But in addition, Dr. Barry set himself * to investigate in detail the more important classes of small-pox cases, making personal inquiry as to every small-pox case that was fatal; as to every case, fatal or non-fatal, that was alleged to have occurred in vaccinated children under ten years of age; and as to every case alleged to have occurred after previous small-pox or after revaccination.

Personal inquiry.

Upon the materials thus obtained, and upon the facts derivable from official records for 1887 and previous years, Dr. Barry's report of the recent small-pox of Sheffield is based.

Method of report.

Before I advert to the results of this report, I would take leave to comment on its method.

Dr. Barry has treated Sheffield, in the first place, sub-district by sub-district, as if he were dealing with eight † several towns, and he reports very completely all the facts concerning small-pox in each. By this procedure he has been able to study, under equal circumstances of that unknown element which is spoken of as "epidemic constitution," the facts as to amount of small-pox and the facts as to prevailing "sanitary" domestic and personal conditions, of eight populations differing *inter se* in some or all of these conditions.

The greater validity and conclusiveness of any uniform result derived from the experience of the several sub-districts regarded as eight separate sources of information, and the value of differences in the experience of the several sub-districts, are considerations that will explain themselves.

Dr. Barry has gone out of his way to avoid stating inferences, preferring to put multitudes of facts upon record; and on this account his report has come to be of considerable dimensions. On the subject of small-pox as seen in England at the end of the nineteenth century, it is a store-house of instruction for such of the public as care to be instructed, and adds in at least one important respect to the information hitherto before the medical profession.

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* The result of each single inquiry thus made by Dr. Barry in person is recorded in the report, every case being stated so as to admit of subsequent identification. This, with other detail, has been introduced on account of the relations of small-pox to vaccination, and other conditions being so often made the subject of gross misrepresentation.

† Dr. Barry, indeed, devotes separate consideration to each of eleven populations; namely, besides the eight sub-districts to which I refer, a portion of Upper Hallam (with 2,631 inhabitants) which lies within the borough boundary, but has little else in common with the town; and the two workhouse populations of Sheffield and Ecclesall. In my own comparisons of sub-district with sub-district I shall exclude these three. But they will be included in all references that are made to the mortality of the borough during one and another time of small-pox prevalence. I need hardly say that cases admitted into workhouse hospitals for treatment have, like cases admitted into the Borough Hospital, been referred to the place of their origin.

[Perhaps, in order to avoid misrepresentation, I may here record that this part of Upper Hallam had, during the recent epidemic, one death, and only one, from small-pox, and that was in a vaccinated adult. There were also 12 non-fatal cases in vaccinated persons, and 1 in an unvaccinated. The population is vaccinated to the extent of 99 per cent. of its number.]

[pp. 163-4.]

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The epidemic of small-pox at Sheffield has turned out to be one of importance, judged on the scale of English epidemics during the last 16 years, and it has stood conspicuously above any other small-pox prevalence of the years 1887–8. During these two years no other large town has suffered from any considerable amount of small-pox. Outbreaks in Prestwich and Preston did not result in a quarter of the small-pox death-rate of Sheffield.

The small-pox epidemic.

For any preference shown by small-pox for Sheffield, as the place to be invaded, I can offer no sufficient explanation. While small-pox exists in England, or can be imported into England from abroad, its introduction into any English community is an affair of circumstance: of the movements of persons and things that are able to carry its infection. Without interference with the movements of the population to an extent that is altogether out of the question, no town in England can guarantee itself against the entrance of small-pox into it. In this respect small-pox does not differ from other diseases, measles for example, that spread by direct personal infection, and that have a long incubation period.

Commencement in Sheffield.

So small-pox in the early part of 1887 made its appearance at Sheffield; in two sub-districts of the borough almost simultaneously. Probably there were two separate arrivals of the infection, but their respective roads are not to be ascertained. The borough was not unprepared for the disease: though in some respects imperfectly, and in some other respects, as the event proves, having made its preparations injudiciously. So far as "sanitary conditions" avail to prevent the extension of small-pox, the place (though not without its faults) was better circumstanced than in former years. As for its disinfection and isolation arrangements, the former were, before the outbreak, of a very rudimentary kind; but the borough had provided itself in 1880 with a hospital for infectious diseases in a central position, and so it was able to seclude almost all of the earlier small-pox cases that came to the knowledge of its Sanitary Authority. This had been its custom for several years whenever stray cases of small-pox had been imported; and for a time it appeared that the usual isolation was producing the usual result of preventing the recurrence of the disease in invaded houses, and of hindering its extension in their neighbourhoods.

Unrecorded cases.

But during the invasion-period of Sheffield a good many cases of small-pox occurred that did not come to the knowledge of the Sanitary Authority. That the Town Council did not become aware of these cases was in a measure due to the fact of their having no special authority to obtain information on the subject of infectious disease prevalence, no more, in fact, than sanitary authorities in general; they had done what lay in their power, by adopting, since 1885, a system of payment to medical practitioners for the notification of new cases of infectious disease occurring in their practice. Not all the small-pox cases that came under medical treatment were notified; and further it is certain that a number of early cases were not notified, owing to the mildness of the disease in individuals leaving them in ignorance of the nature of their complaint, and leading them to consider medical advice unnecessary. Thus, in the one way or the other it came to pass that up to May 1887, during the early period of the growth of the epidemic, only eight cases were notified to the Health Authority, whereas thirty-two cases, actually occurring during this very period, came under their cognizance when they set on foot inquiries of their own.

Extension of small-pox

Then the disease gently extended itself during June and the early part of July; supplying from various quarters of Sheffield occasional cases to the Borough Hospital, while very few (of the known cases)

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stayed at their own homes for treatment. But now the experiences, familiar to your Board, of small-pox obtaining extravagant proportions in the neighbourhood of a small-pox hospital, centrally placed, began to be witnessed at Sheffield. *See maps at page* 276. Looking at the occurrences of this period by the light of subsequent events, it would seem probable that from the beginning of June the hospital in Winter Street was playing the part of small-pox distributor; but as to its agency after the first week in July there can be no doubt. Something of its operation was indeed soon recognized by local observers; and the completed record of this period shows the houses in a circle of 4,000 feet round the hospital to have become attacked almost suddenly to a degree amounting to a dozen-fold the rate of the rest of the borough. Sixty new invasions during the fortnight ending July 16th, were distributed as follows, per cent. of houses situated at successive distances from the hospital:—

especially over a "hospital area."

[p. 275, table.]

0–1,000 feet.	1–2,000 feet.	2–3,000 feet.	3–4,000 feet.	Elsewhere.
1·75	·50	·14	·05	·02

From this time onwards, it may confidently be said, the Borough Hospital at Winter Street, whatever service it may have rendered to particular families or to remoter districts, operated to the disaster of central Sheffield; and it must remain (to say the least) an open question whether throughout the epidemic period as a whole the hospital did not do more harm than good to the borough.

As regards the method by which the hospital exerted its influence upon its neighbourhood,—whether through the general atmosphere or by personal communication,—we learn nothing from the experience of Sheffield. Dr. Barry has found it beyond his ability to exclude the operation of certain faults of administration,—faults of notable amount and of a nature to allow of the transmission of small-pox by the persons of officers of the hospital and of visitors to the hospital; and so has not been in a position to enter on the question of aërial dissemination *per se*.

Circumstances of hospital influence.

In the fortnight of June, when the hospital began to exert a probable, but not unquestionable, influence on the area surrounding it, the average daily number of small-pox patients in the hospital was 14, and in that fortnight four cases only had been newly admitted. In the fortnight of July, when the influence of the hospital began to be unequivocally exerted, the average daily number of patients in the hospital was 36 and in that fortnight 14 cases had been newly admitted.

[p. 279.]

Amount of hospital influence,—

Some judgment may be formed of the extent of the total influence exerted by the Winter Street Hospital upon the prevalence of small-pox in Sheffield and its various parts, by weighing the following summary results culled from Dr. Barry's report. They have reference to the whole epidemic-period up to March 31st, 1888.

as indicated by distribution in sub-districts:

(*a.*) Within a mile of the hospital are situated the whole of the sub-districts of North and West Sheffield, along with portions (small, but rather the more populous) of Nether Hallam and Ecclesall sub-districts. The Winter Street Hospital was established in 1880, since the time when small-pox was last epidemic in Sheffield. North Sheffield had in earlier small-pox epidemics experienced more than its share of the small-pox death-rate of the borough; on this occasion its death-rate was still more conspicuously high, relatively to the common death-rate of the

borough. West Sheffield had thrice held, among the sub-districts, a favourable rank (below the average), and once a rank above the average of the borough; on the recent occasion its death-rate up to March 31 was two-and-a-half times the average of the borough,—a degree of excess never before recorded of it or of any sub-district. Nether Hallam (into which, however, it will be remembered, small-pox was first introduced during the recent outbreak) has not shared in the general death-rate to an average degree, yet it bore a somewhat larger share than had been its wont in former epidemics. Ecclesall (with a population mostly suburban and rural) is in its usual favourable rank among the sub-districts relatively to the common death-rate of the borough.

and by incidence of small-pox on special area.

(*b.*) Shortly before the conclusion of Dr. Barry's inquiry, the patients were taken from Winter Street Hospital to a new hospital four miles away from the centre of the borough, and the excessive incidence of small-pox upon the Winter Street neighbourhood thenceforth disappeared.* The whole period of direct influence of the hospital is thus comprised in Dr. Barry's report; and it turns out that throughout the nine months the houses within a 4,000 feet circle had been invaded to twice the extent, and the houses within the area of a 2,000 feet circle had been invaded to three times the extent, of houses situated elsewhere in the borough.

Influence of general sanitary circumstances; (*a.*) in one and another locality.

It is hardly necessary to point out that, owing to the peculiar localization of small-pox in Sheffield due to the influence of the hospital near its centre, the distribution, during the recent epidemic-period, of small-pox according to the *general sanitary circumstances* of the several sub-districts has become a matter difficult to apprehend in its right proportions. And it is not less obvious that we cannot now with confidence resort to the experience of former epidemics, before the hospital existed, for information as to varieties in the local distribution of the disease, because of the changes that have taken place in the population of the respective sub-districts as well as in the local sanitary arrangements of the borough since the last occasion that small-pox was epidemic there. But, upon a general review of the evidence adduced by Dr. Barry, this much may, I think, be affirmed with confidence: the one "*sanitary circumstance*" which availed to cause inequalities in the incidence of small-pox upon one and another sub-district during a series of years was essentially the greater or less degree of spaciousness or of crowding, of houses upon area and of people within their homes. No other circumstance within the compass of "sanitation" appears to have had any correspondence with the specialities of local distribution of the disease. Small-pox in this respect used to bear a certain resemblance to measles and whooping-cough. An advantage, not exceeding two to one, may perhaps be set down as having formerly represented the value of sanitary circumstances in the healthiest sub-district of the town as compared with the unhealthiest parts of the borough. But this advantage, whatever it used to be, cannot (for the above stated reason) be confidently affirmed for the recent epidemic.

(*b*) at one and another period. Comparative observations of other epidemic diseases, and

I turn to consider the fall in the mortality of small-pox as compared with other epidemic diseases since the more vigorous adoption of sanitary measures in Sheffield. Between an earlier and a later period, each of 10 years, measles, scarlatina, whooping-cough, and diarrhœa,

* It is true the epidemic itself was at this time on the wane; and Dr. Barry supplies very good reasons for believing that its decline was hastened, especially in the hospital neighbourhood, by the removal of the Winter Street cases.

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[p. 266, table.]

have fallen in their respective death-rates in the following proportions; measles from 100 to 78, scarlatina from 100 to 73, whooping-cough from 100 to 93, and diarrhœa from 100 to 72. Diphtheria and "fever" death-rates have fallen to a greater extent; namely, diphtheria in the proportion of 100 to 39 and fever from 100 to 34.

We want to know, for comparison with the foregoing, what change has been effected between earlier and later times in respect of the rate of death by small-pox:—

> Here we are at once met with a difficulty by reason of the rarity of small-pox in Sheffield during recent years. The 10 years that serve for an estimate of the habitual prevalence and of the alterations in prevalence of other diseases do not suffice in the case of a disease which can be practically absent for 14 years together. To choose for comparison with the earlier period any 10 years out of these 14 would manifestly lead to error, inasmuch as (we now know) small-pox was destined presently to reappear in the borough.
>
> I shall regard for the present purpose the whole of the recent epidemic as forming a set-off against the long suspension of small-pox prevalence; and therefore shall assume, for the whole 16 years 1873–88 inclusive, a uniform rate of small-pox mortality.* Any ten of these 16 years may very properly be taken as representing, for comparison with an earlier decennial period, the more recent death-rate of the borough.
>
> [During the earlier 10 years 1861–70 this kind of correction is not called for, since small-pox was never during any twelvemonth of that period altogether absent from the death-registers in the fashion that it has been repeatedly absent during several twelvemonths since 1872.]
>
> Thus we get to a representative total mortality of 465 during a recent decennial period or a mean of 46 deaths annually; and on the population of Sheffield we obtain an annual small-pox death-rate among people of all ages of 16·3 per 100,000. This 16·3 is the rate which may most properly, I hold, be compared with the antecedent rate of 58 annually during 1861–70.

of small-pox.

The earlier death-rate from small-pox at all ages in Sheffield bears to the corresponding later death-rate the proportion of 100 to 28. Wherefore the reduction in the mortality of small-pox has been conspicuously greater than in the mortality of measles, scarlatina, whooping-cough, or diarrhœa, and has been something greater than the reduction (great as that has been) of the mortality at all ages from diphtheria or from fever. This, then, has been the experience of the population of people of all ages living in Sheffield.

Fall in mortality from other infections similar among persons of one or another age.

I now invite attention (and I would require this attention from anyone who shall profess to base conclusions relating to small-pox upon the above facts) to the experience of the *population of various ages* living in Sheffield. Taking the same periods of years as in the case of persons at all ages, the reduction in the rates of death from infectious diseases generally is found not to have been greatly different for one or another period of individual life. Thus the reduction (22 per cent. as before stated) in the death-rate from *measles* in people of all ages, is the resultant of a reduction of 22 per cent. in children† and 40 per cent.

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* Dr. Barry has been content to take for his later period the same 10 years that he uses for his examinations of change in the death-rate by other epidemic diseases, and he thus includes 1887, and with it a portion (but only a portion) of the recent epidemic-period. His result is to represent the decrease of small-pox prevalence at all ages as being in the proportion of 100 to 18.

† By "children" in this passage, I mean those under 10 years of age.

among the dozen or so of their elders who died from measles; the reduction (27 per cent. as before stated) in the death-rate from *scarlatina* is the resultant of a reduction of 27½ per cent. in children and 25 per cent. in their elders; the reduction (61 per cent. as before stated) in the death-rate from *diphtheria* is the resultant of a reduction of 67 per cent. in children and 50 per cent. in their elders; the reduction (7 per cent. as before stated) in the death-rate from *whooping-cough* is a reduction altogether in children, their elders not dying at either period from the disease; the reduction (66 per cent. as before stated) in the death-rate from "*fevers*" is the resultant of a reduction of 74½ per cent. in children and 61 per cent. among their elders; the reduction (28 per cent. as before stated) in the death-rate from *diarrhœa* is the resultant of a reduction of 28 per cent. in children and of 23 per cent. among the few elders who die from diarrhœa.

Fall in small-pox mortality quite peculiar to childhood. No fall in elder persons.

Now let the corresponding facts appear for *small-pox*. The reduction between the earlier and the later period (72 per cent. as before stated) in the death-rate from small-pox in people of all ages, is made up (*a*) by a *reduction of no less than* 90 *per cent. below the large earlier death-rate among children* along with (*b*) *an actual increase of* 34 *per cent. beyond the small earlier death-rate among elder people.* There has been nothing of this sort in the behaviour of any other infectious disease.

Recapitulation as to nature of influence reducing mortality.

As regards the recent relations of small-pox to sanitary circumstances in Sheffield, the case then stands as follows:—Owing to the peculiar localization of small-pox effected by the operation of the Borough Hospital, evidence as to the influence of local "sanitary conditions" cannot be derived from recent facts. If we might appeal for an analogy to other diseases that are conveyed like small-pox by personal and atmospheric infection, it would point, if the analogy were to be trusted, to a fall of some 10–30 per cent. as having perhaps been due to improvements in dwellings and other sanitary conditions. If we were to appeal to diphtheria or "fevers" for a like analogy, it would (supposing it were to be trusted) point to a fall of some 60–70 per cent. due to improvements of the like sort. But these analogies are seen to be hopelessly false when the age-components of the fall in small-pox death-rate and in other death-rates are examined. Small-pox, unlike any other of these diseases, has *risen* in its death-rate *among people over childhood;* and the remarkable fall observed in its all-age mortality is exclusively due to the enormous decline of its mortality *among children.* The agency productive of the decline of small-pox mortality, whatever that agency may have been, has unquestionably not been of the same kind as the agency that has produced the decline in the mortality of other infectious disease. It has been an agency *different in nature* from the agency of "improved sanitary conditions."

It is different for small-pox and other infections.

Let it be noted, as a circumstance suggested by the 14 years of comparative absence of small-pox, that the agency in question apparently began to exert itself somewhere about the end of the period 1861–70, or in the interval between 1870 and 1873, or soon after the commencement of the period 1873–88.

Did it consist in the influence exerted by the small-pox epidemic that pervaded England in 1871–72,—years in which 1,007 persons died from small-pox in Sheffield?*

* These years, owing to their extravagant mortality, are purposely excluded from the comparison of earlier and later small-pox periods. In the hope of avoiding misrepresentation, it may be proper that I should say, that if these years were included with the period 1861–70 the case in favour of the latter period 1873–88 would be far stronger than above represented. There can be no suggestion of including 1871–2 with the later period.

Probably, to a trivial extent, an influence of this nature was exerted for some people in Sheffield; namely, for those few thousands who had acquired the insusceptibility against small-pox that is conferred by a previous attack of the disease. But the epidemic of these years cannot be credited with any influence of the sort we are seeking, seeing that the speciality of the reduction in small-pox mortality consists in the saving of life to children who were not born in 1872.

Or did the exceptional agency we are in search of consist in the isolation provision made by the borough authorities for the reception of infectious sickness. Let that provision, operating since 1880, be at once credited with having postponed the appearance of a small-pox epidemic in the borough; as it received a number of imported cases at various times and *pro tanto* diminished the opportunities of small-pox spread. But it can have had nothing whatever to do with a reduction of small-pox death-rate *special to children*. When we have included the actual epidemic of 1887–8, we find that less than one out of five, of the small-pox cases occurring during the last 16 years, got taken to hospital; and that, as matter of fact, the disease was able to spread (to say the least, in despite of the hospital) about the town; that it killed the people over 10 years old more abundantly than it had killed them before; and that it avoided the age of childhood, the very age which habitually suffers more than other ages from natural small-pox. This result cannot have been brought about through any agency exerted by the isolation provision of the borough.

Or, since the influence we seek is one special to children, has it been an occupational or educational difference of recent origin that has thus made the children less liable to die of small-pox? I cannot conceive what such a thing should be, nor how such an influence should have operated for reducing small-pox mortality in children without reducing at the same time and in like manner the mortality of children from measles and whooping-cough.

Necessary attributes of the agency which has reduced small-pox.

Some sort of "rite" would indeed appear to have been practised upon Sheffield children; some practice coming newly or more abundantly into use since 1870 or thereabouts; some practice availing to prevent children dying from small-pox; and having no similar avail against any other infection to which childhood is subject.

Up to this point, I have avoided mentioning the word "vaccination." It has been my object to discover, if it were possible, some influence other than vaccination to which the decline of small-pox and the behaviour of small-pox during the recent epidemic might be ascribed. I have been led to take this course owing to the assertion frequently made by those who make it the business of their lives to decry vaccination, that the decline of small-pox in England, Germany, and elsewhere is a simple affair of improved sanitary circumstance: a curiously mistaken assertion which, strange to say, has been adopted into the article "Vaccination" of the new edition of the Encyclopædia Britannica.

Vaccination. Increased practice of.

Let us see now what have been the relations of Small-pox to Vaccination in Sheffield.

The inhabitants of Sheffield have, of late years, obeyed the vaccination laws of 1867 and 1871 as completely as the average of English commu-

nities; or perhaps somewhat better than the average. In 1862, at an inspection of the borough school children by an Inspector of the Privy Council, 13 or 14 per cent. were found unvaccinated; at the "vaccination census" of 1888 less than one per cent. of children of school ages were found in that state.

Unvaccinated remainder provides crucial experiments.

In the borough, among people of all ages, there has been enough omission for the enumerators to have reckoned two per cent. of unvaccinated persons. The unvaccinated community, distributed throughout the various sub-districts, under like circumstances, with the vaccinated, has been of sufficient magnitude to form a valid crucial experiment as to the relations of small-pox to vaccination.

This two per cent. of the population claims to be regarded as so many seventeenth or eighteenth-century people scattered about Sheffield, for the very purpose of having themselves compared, under nineteenth-century conditions of life, with the law-abiding people of the present period.

Demonstration of experimental results.

Dr. Barry reports the results of this comparative experiment, in words, in tables, in diagrams: he reports the facts about small-pox attacks and small-pox deaths, in vaccinated and unvaccinated respectively, for sub-district after sub-district; for localities suffering much or suffering little; for populations living in actually invaded houses and infected institutions; for one age and for another age; for one or another state of individual health—the whole with a repetition that is monotonous because the one fact turns out to be uniformly the same, for sub-districts, for locality, for infected house or institution, for age, or for previous health. Dr. Barry's instruction was to observe the influence of every circumstance as well as the influence of vaccination; and he has found no influence that has not been dominated by the single influence of vaccination.

Uniformity and monotony of them.

To state in successive propositions each set of circumstances under which small-pox was observed to differ, when the vaccinated and unvaccinated came to be compared, would be to reproduce a great part of Dr. Barry's report; where he formally records, in parallel passages, upwards of a hundred such differentiating experiences. I propose only to take from the report a few of the summary facts concerning the vaccinated and the unvaccinated *in the Borough generally*, premising that statements here made concerning the whole borough are (when not otherwise stated) approximately correct for the several parts of the Borough.

A few gross results here exhibited.

The facts as to vaccination or no vaccination depend for the most part upon information supplied to the census enumerators by heads of families, patients, and relatives. As already said, the more important sorts of information were specially checked by Dr. Barry's own investigations, which we kept up in respect of cases occurring before the end of March. I shall not have much to say about later occurrences.* The house-to-house visitation was unquestionably the most important performance of its kind that has ever been attempted, and I regard its results as being as exact as the work of careful and conscientious men

* There is no reason whatever for supposing that the contrasts between vaccinated and unvaccinated would be affected by including the waning stages of the epidemic. Such inclusion would no doubt alter the total numbers recorded by Dr. Barry, and of course the actual attack-rates and death-rates of the population during the epidemic; but as regards contrast between vaccinated and unvaccinated, it is of no importance whether three-quarters or the whole epidemic period be taken.

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can be.* Dr. Barry's refusal to admit into his comparison babies under a month old may be noticed in passing as one among many indications of his own desire to avoid anything like exaggeration in statements of contrast between vaccinated and unvaccinated.

A. For children under 10; generally; [p. 172, table.]

A. First, of the *children under* 10 *years of age* living in Sheffield during 1887–8 under the common conditions of infection in the whole borough.

Per thousand of the number of children in each class;

the attack-rate† of the vaccinated was	5
the attack-rate† of the unvaccinated‡ was	101
the death-rate† of the vaccinated was	0·09
the death-rate† of the unvaccinated‡ was	44

[Let me state this difference in other terms: For 100,000 vaccinated children, the rate of small-pox mortality actually observed in Sheffield gives 9 deaths. For 100,000 unvaccinated children, the rate of small-pox mortality actually observed gives 4,400 deaths.]

Under the general circumstances of the Sheffield epidemic, therefore, the *vaccinated children* had as compared with the *unvaccinated children* living in the town a twenty-fold immunity from attack by small-pox; and had a 480-fold security against death by small-pox.

living in invaded houses.

The above relates to the general children-population of the Borough. *Children living in houses actually invaded* were of course exposed to an intenser and more continuous infection; and, be it well remarked, the vaccinated were to a nicety, exposed to identical external conditions for infection and for death with the unvaccinated; being common inmates of the very same infected houses.

[p. 173, table.]

Per thousand of the number of children of each class living in invaded houses,

the attack-rate of the vaccinated was	78
the attack-rate of the unvaccinated‡ was	869
the death-rate of the vaccinated was	1
the death-rate of the unvaccinated‡ was	381

Under these extreme yet identical circumstances, therefore, the *vaccinated children* had as compared with the *unvaccinated* an 11-fold immunity from attack by small-pox, and a 381-fold security against death by small-pox.

B. For persons over 10:

B. Next, concerning *persons over* 10 *years of age* living in Sheffield during 1887–88 under the common conditions of infection of the Borough. The vaccinated and unvaccinated members of this class are

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* Now and then Dr. Barry found discrepancies between the Census data, as presented to himself, and the records gathered from other sources and given to him by the Health Office; and he considers in his report the nature and magnitude of such discrepancies, giving reasons for a general preference of the Census data. The discrepancies do not bring into question Dr. Barry's results as between vaccination and no vaccination. Perhaps I ought to add that the Health Office data, when they differed on this point from Census data, went to make the evidence still more striking in favour of the protective influence of vaccination.

† In this place and in what follows about vaccinated and unvaccinated during the recent epidemic, let it be recalled that the actual rates have reference to the period of the epidemic from April 1887 down to the end of the census of Feb.—March 1888. The rates are not to be taken as annual rates or rates for the total epidemic. But, in every case stated, for vaccinated and unvaccinated alike, they relate to the same area during this same period.

‡ It has been said, by way of cavil, that an unvaccinated population comprises children under one month of age. Attacks and deaths among these infants, however, are excluded throughout these statements of contrast. Their inclusion would of course make the contrast more striking in favour of the protective influence of vaccination.

found to have always differed to a considerable degree from each other; both in regard of attack and of death, and also whether the Borough as a whole or its component sub-districts be examined. But this degree of difference (considerable though it has been) has not been nearly so large as in the class of children.

Per thousand of the number of persons over 10 in each class,

the attack-rate in persons twice vaccinated* was 3
the attack-rate in persons once vaccinated* was 19
the attack-rate in persons not vaccinated† was 94
the death-rate among persons twice vaccinated* was 0·08
the death-rate among persons once vaccinated‡ was 1
the death-rate among persons not vaccinated† was 51

[Let me state the difference in other terms:—For 100,000 persons over 10 years old and twice vaccinated, the rate of small-pox mortality actually observed would give eight deaths. For 100,000 persons over 10 years old and once vaccinated, the rate of small-pox mortality actually observed would give 100 deaths. For 100,000 persons over 10 years old and not vaccinated, the rate of small-pox mortality actually observed would give 5,100 deaths.]

Under the general circumstances of the Sheffield epidemic, therefore, the *twice vaccinated persons over* 10 *years of age* as compared with the *unvaccinated* persons of the same age living in the town, had a 31-fold immunity against attack by small-pox, and had a 640-fold security against death by small-pox.

Re-vaccination apart, the people *over* 10 *years* living under these general circumstances had, if they were *vaccinated* at all, a 5-fold immunity against attack by small-pox, and a 51-fold security against death by small-pox, compared with the *unvaccinated* people of the same age.

Once-vaccinated people over 10 years of age constitute the great majority of the inhabitants of Sheffield. It is demonstrated by the above comparison that these people had lost a great measure of the protection against small-pox which as children they once possessed, and that they had not acquired any such additional protection as was possessed by persons of their age who had undergone a second vaccination.

Now as to the value of any protection obtained by vaccinated persons of this class, viz., *aged over* 10 *years*, who live, not under the general circumstances of Sheffield, but in *houses actually invaded by small-pox*, the following were the observed rates per 1,000 of such persons of the vaccinated and unvaccinated classes respectively:— living in invaded houses.

the attack-rate of the vaccinated was 281 [p. 173, table.]
the attack-rate of the unvaccinated was 686
the death-rate of the vaccinated was 14
the death-rate of the unvaccinated was 371

Wherefore, under these extreme conditions, identical for vaccinated and unvaccinated, the *vaccinated* people over 10 years of age had, as compared with the *unvaccinated*, a more than double immunity from attack by small-pox, and a 26-fold security against death by small-pox.

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* That is, revaccinated *before* the recent epidemic began. Facts as to those revaccinated *during* the epidemic are given by Dr. Barry, but they often have reference to operations performed during the incubation of small-pox, and they do not readily admit of being summarised.

† Persons who had previously passed through an attack of small-pox were attacked at the rate of 1·3 and died at the rate of 0·3 per 1,000 of their number. [p. 202.]

‡ Including the comparatively small class of twice vaccinated.

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The difference between vaccinated and unvaccinated, when persons over 10 are in question, is again seen to be less, and now to be vastly less, than in the case of children.

C. People of all ages: generally:

C. We now come to consider the influence that has been exerted by vaccination upon the *people of all ages* living in Sheffield.

Under the common conditions of small-pox infection in the Borough generally, the vaccinated and unvaccinated *persons of all ages* have during 1887–8 differed from each other in respect of small-pox. This difference between the vaccinated and unvaccinated classes, when people of all ages are considered, is of necessity intermediate in amount —more conspicuous than in the case of persons over 10, less conspicuous than in the case of children under 10.

[p. 172, table.]

Per thousand of the number of persons of all ages in each class,

the attack-rate in the vaccinated was	15·5
the attack-rate in the unvaccinated was	97·
the death-rate in the vaccinated was	0·7*
the death-rate in the unvaccinated was	48·

It follows that under the general circumstances of Sheffield during the epidemic, the *vaccinated persons at all ages* had, as compared with *unvaccinated* persons at all ages, a 6-fold immunity against attack by small-pox, and that they had a 64-fold security against death by small-pox.†

living in invaded houses.

Restricting the comparison, once again, to the vaccinated and unvaccinated *people of all ages* who lived under the identical but extreme circumstances of small-pox infection, *in invaded houses*.

[p. 173, table.]

Per thousand of the two classes of people,

the attack-rate in the vaccinated was	230
the attack-rate in the unvaccinated was	750
the death-rate in the vaccinated was	11
the death-rate in the unvaccinated was	372

Wherefore under these extreme but identical conditions of small-pox infection, people of all ages in Sheffield had, if they were *vaccinated*, a more than treble immunity against attack by small-pox, and a 34-fold security against death by small-pox as compared with their *not-vaccinated* fellow residents in invaded houses.

The ratio for the borough of 1 : 64 in the respective death-rates from small-pox among vaccinated and unvaccinated people of all ages, taken together, has not been found the same for each of the several sub-districts. Where there was but little small-pox the ratio could show somewhat wide departures from the mean ratio of the borough; but where there was most small-pox, in North Sheffield and West Sheffield, there the ratio of death-rate in vaccinated to death-rate in unvaccinated proves to have been 1 : 64 and 1 : 61. Among the vaccinated, the actual death-rates in sub-districts varied between 0·5 and 1·7 per 1,000 living; among the unvaccinated, they varied between 27 and 104 per 1,000 living.

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* The ratio of 0·7 to 48 is 1 : 68, but taking into account second places of decimals, 1 : 64 is the truer ratio. The same correction has not been considered necessary in the case of other ratios.

† Dr. Barry has not been unmindful of the contention, which has been seriously advanced, that the greater mortality of small-pox among unvaccinated persons is due to the previous more feeble health of the people who are attacked and who die. He sought to get the opinion (valeat quantum) of relatives as to the state of health in which people found themselves at the time of their fatal attack, and he has got this information in nearly 19 out of every 20 cases of death by small-pox. The vaccinated and unvaccinated had very little difference between them in respect of their previous health, as thus described by their friends: 35 per cent. of the one sort, and 31 per cent. of the other sort were described to him as being in an unsatisfactory condition of health at the time of their attack.

[pp. 197–199.]

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There is interest in a comparison of this ratio 1 : 64 with the corresponding ratio obtained at the vaccination census of St. Pancras made in 1884. That census showed the death-rate in vaccinated people of all ages to hold, to the death-rate in unvaccinated people of all ages, the ratio of 1 : 77. But on that occasion the fact of vaccination could not be ascertained for some of the fatal cases; and thus there are limits of error between 1 : 43 and 1 : 141. The ratio of 1 : 64 in Sheffield is based upon data that may be considered for every practical purpose to be complete.

I may here mention—what to a generation that had not lost its familiarity with small-pox, would go without saying—that what was found true of the fatality of small-pox at Sheffield was found to be also true of the injury done to the individual sufferers who survived. From the experience of 1,741 patients treated in hospitals down to March 31st, Dr. Barry reports 17·2 severe and confluent cases out of every 100 small-pox patients of all ages who had been vaccinated, and 81·5 of the same forms of small-pox out of every 100 attacks in people of all ages who had not been vaccinated; and for children under 10 the corresponding figures were 9 and 78. Confluent (as opposed to discrete) means, in this connexion, not only the more fatal form of small-pox, but also the small-pox which produces a vastly greater quantity of pitting and scarring, of blindness and other disfigurement, among those who survive the attack. [p. 210.]

living in hospitals;

In the hospitals, the familiar immunity of revaccinated persons in attendance on the sick was observed. There were 161 persons employed in the wards and offices of five hospitals. Of the 161, 18 had had small-pox before their engagement and none of these fell ill; 62 persons (all of them workhouse-hospital nurses) had been vaccinated in infancy only, and of these 6 were attacked and 1 died: the remaining 81 persons had been successfully revaccinated, and not one of these contracted small-pox. [p. 206.]

troops;

It is opportune to mention in this place other classes of the population whose vaccination is, in profession at least, specially cared for. Of 830 troops of all ranks, nominally all revaccinated, there were 12 men attacked by small-pox and one died. The medical officer in charge of the troops, informing Dr. Barry of these facts, reported that the operation of revaccination had been attempted for these 12 men, but that in every single instance it had been unsuccessfully performed. [p. 205.]

police;

Of 372 men in the Borough Police Force (where there is no rule as to revaccination on admission), 10 constables who had been vaccinated but not revaccinated, took small-pox before February 10th 1888, when an order for universal revaccination of the force was issued. Thenceforward, till the end of the epidemic (according to some supplementary information furnished to the Inspector), there was no other attack among the police. [p. 205.]

postmen.

Of 290 men and boys on the permanent staff of the Sheffield Post Office, the whole had been revaccinated at the time of their engagement. Throughout the epidemic, up to August 1888, no member of the staff contracted small-pox. [p. 206.]

We had, before considering vaccination, found ourselves in search of some influence exerted, possibly of some "rite" practised, for the purpose of preventing death by small-pox. We had been presented with a fall in the small-pox mortality of the Borough in excess of the fall in its mortality from other infectious diseases; and the fall in the death-rate from small-pox had showed the peculiarity of being wholly an affair of childhood. We could discover nothing in the nature of "improved

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sanitary circumstances" competent to explain this peculiarity in the reduction of the small-pox death-rate. We wanted to find an influence, capable of explaining this special fall in the children's death-rate from small-pox, that should have come newly or more abundantly into use somewhere about the interval between the 10 years 1861–70 and the 16 years 1873–88. Inasmuch as the observed degree of fall among children was in the proportion of some 10 to 1, the operative influence or "rite," whatever it was, should have been newly exerted or newly performed in some similar degree. It was to be operative specially or exclusively for protection against the one disease, small-pox.

The necessary attributes of an agency that has reduced small-pox

found by Sheffield experience

Thanks to those whom I have called an experimental population belonging to the 18th century, living in Sheffield under 19th century conditions, we now discover that there has existed there a certain "rite," the omission or performance of which has made a difference of 480 : 1 in the mortality of children from small-pox.

to be possessed, very precisely by "vaccination."

This rite, called "vaccination," was (we have seen) formerly omitted to the extent of some 13 or 14 per cent. Acts of Parliament passed in 1867 and 1871 provided more efficiently for the general performance of vaccination in infancy. Consequently the neglect of the "rite" has been reduced from about 13 or 14 to about 1 or 2 per cent. In the period (inclusive of the recent epidemic) subsequent to those Acts, as compared with the period before their operation was felt, small-pox mortality has been reduced in almost equal measure; namely, in children under 10, reduced from 10 to 1.

"Vaccination" alone wanted to explain observed reduction of small-pox at Sheffield.

If one had never heard of "vaccination" but had only the evidence of this particular report, differentiating attacks and deaths by small-pox among each and all of eight populations according as individuals had or had not received a certain "rite," there would be ground for strong belief in the protective value of the rite, and reason for seeking its general adoption. And when it turned out that the rite in question was none other than that which, 90 years ago, was brought into use for the express purpose of protecting against this very disease; and, in addition, that major acceptance of the rite has been accompanied, in exact measure, by major security against small-pox; it would seem that no reasoning mortal could hesitate to find in this rite, THE cause, and THE ONLY CAUSE, wanted to explain the observed phenomena. It is to the more general use of vaccination for Sheffield children that the Borough owes the reduction effected in its small-pox death-rates, viz., for people of all ages a reduction of 72 per cent. below the former amount; and for children, a reduction of 90 per cent. below the former amount.

Vaccination specially protective to children;

For the protection of persons over 10 years of age in Sheffield this same infantile vaccination has availed, as we have seen, in a very important degree. To this class of the population the omission or performance of vaccination in their infancy has made a difference of 51 to 1 in the death-rate from small-pox. But we have seen that the degree of insusceptibility possessed by the aggregate community which has passed the age of 10 years is less than that possessed by younger persons, and less (no doubt) than that possessed by the individuals of the same community during earlier periods of their own lives. But, none the less, the actual death-rate among people over 10 in Sheffield has been greater than the death-rates of the same people during earlier years. How is this explained by the "influence of vaccination"?

its influence on persons over childhood.

The Registrar-General, in a passage, which I have before quoted (in my report for the year 1884), has thoughtfully considered the reasons for an observed increase of small-pox death-rate among people in later life when earlier and later periods are compared together. Recording for the whole kingdom an increase similar to that seen at Sheffield, he

points out that it is only what was to be expected from the substitution of a less durable for a more durable insusceptibility. The vaccine protection is admittedly the less durable.

If the fact of such increase stood alone, it would be a circumstance derogating from the advantage of vaccination to a community; but the increase is found (1) to be an increase upon what was previously small, (2) to be an increase therefore not incompatible with a total decline from 100 to 28 in the small-pox death-rate among persons of all ages living in Sheffield, while (3) the more transient immunity against small-pox conferred by infantine vaccination is shown by all experience, and now by the experience of Sheffield, to be renewable by a second vaccination performed after 10 years of age. By this renewal, we learn from Dr. Barry, an insusceptibility equal in durability to the insusceptibility derived from a previous attack of small-pox, was gained at Sheffield; and it was gained without the expense of one person's death for every two persons who acquired it.

[The quoted passage is as follows (R.G., 43rd Annual Report, p. xxiii.):—

"Doubtless, at first sight, this progressive rise in the small-pox rates at the later life-periods seems incompatible with the asserted protective influence of vaccination; but on further consideration it will be seen that this is not the case, and indeed, that such rise is what might naturally be anticipated from what is known as to the character and degree of the immunity conferred by vaccination. For it is pretty generally recognised, and this on good grounds, that the immunity derived from vaccination is both less perfect and less permanent than that conferred by small-pox itself; its efficacy diminishes with the lapse of time, while the protective influence of small-pox remains practically unaltered. If we admit the existence of this difference between the two forms of immunity, we have the following explanation of the fall of the rate in early life and its rise at the later ages.

"Before vaccination came into use, few persons escaped having small-pox at some or other time in their lives. The great majority had it when young, and of these a large proportion died, causing a very high death-rate in the earlier age-periods. But those who survived the attack enjoyed a practically complete immunity for the rest of their lives, and, as they formed a considerable proportion of the population at the later age-periods, the small-pox death-rates at these periods of life were very low. But when vaccination comes into use, and in proportion as its use became more and more general, the relative conditions of the different age-periods as regards immunity were materially altered, and partially inverted. Childhood, previously altogether unprotected, now received a very considerable immunity; while the later ages, previously much protected, now had their immunity considerably diminished, and the more so, the later the period of life and the more remote therefore the date of vaccination."]

To sum up:—There has prevailed in Sheffield during 1887–8 an epidemic of small-pox giving rise during the two years to 22·2 attacks and 2·07 deaths per 1,000 population of all ages. Up to the period (March 31st, 1888) when 19·3 per 1,000 attacks and 1·87 per 1,000 deaths had taken place, this epidemic was carefully studied by Dr. Barry.—It has been found that if so-called "sanitary circumstances" have had any influence at all upon the rate of attack and death, such influence is not demonstrable, and can, at the utmost, have been but

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small.—It has been found that the Borough Hospital is accountable for a special prevalence of small-pox upon central Sheffield, and it must remain under suspicion of having helped to magnify the epidemic in the town.—It has been found that the children of Sheffield have had a far smaller death-rate from small-pox than in previous epidemics, and that they have during 1887–88 borne a quite inconsiderable share* of the total small-pox attacks and mortality; a share vastly less than that ever borne by the children during earlier periods; and that (seeing what we do see of the protective value of infantile vaccination during this epidemic) this circumstance cannot but have been due to the more general performance of vaccination in infancy.—It has been found that people over 10 years of age in Sheffield have, on the contrary, experienced an actual rise on their previous small-pox death-rate, and that these people have borne during the recent epidemic a quite extravagant share of small-pox attacks and mortality.—It has been found that, in spite of this rise, the whole population of the Borough has now-a-days, owing solely to the enormous reduction of the death-rate in children, a small-pox death-rate of 72 per cent. below its former amount. It has been shown that where people over 10 have undergone a second vaccination they have recovered the immunity from small-pox which they had as children.

Saving of small-pox attacks and of small-pox deaths.

In concluding this introduction to Dr. Barry's report I could have wished to frame a numerical estimate of the saving, effected by vaccination, in small-pox attacks and in small-pox mortality during 1887–8, but I find this to be impracticable. The reason of my inability is, that without vaccination, the conditions of the Sheffield population in respect of their susceptibility to small-pox would have been so widely different from what they actually were at the commencement of the recent epidemic. In the absence of all vaccination, the older population would have obtained, in large numbers, the protection afforded by surviving a first attack of small-pox.

But what is quite certain is that if the vaccinated children of Sheffield had up to the date of the census been attacked at the rate that the unvaccinated were attacked, there would have been close upon 7,000 attacks among such children in the place of the actual 353, and there would have been close upon 3,000 deaths among such children in the place of the actual 6 deaths. [Or we may read, "there would have "been, *up to the conclusion of the epidemic*, 4,400 deaths among such "children in place of the actual 9 deaths."] Here we may see what vaccination has done for Sheffield children under 10 years of age.

For the rest, though I cannot profess to estimate what vaccination has done, within the limits of the recent epidemic, for the population over 10 years living in Sheffield, I may point out, for those who can imagine a sudden and complete forfeiture in 1887 by all the inhabitants of the protection which they have from vaccination, that the 200,000 people over 10 living in Sheffield would (at the current rate of death observed among unvaccinated persons of that age up to the date of the census) have experienced over 10,000 deaths instead of the actual 368.

I notice that Dr. Barry, in a passage where he is concerned with numerical comparisons only, speaks of the recent epidemic as of "com-

* The share of small-pox mortality borne by children, and the regular decrease of this share since vaccination has become more generally practised for Sheffield children, are matters exhibited in diagrammatic form by Dr. Barry, who has for the purpose examined the last five epidemic periods. Readers of intelligence do not need to be reminded that increased *share* borne by persons over 10 years of age, does not imply a change (one way or the other) in the actual *death-rate* of such persons.

parative insignificance." As it stands, the phrase may, I think, be liable to misconstruction. So far as can be judged from the readiness with which the disease spread, from its persistence in the Borough, and from its rate of fatality, I should be disposed to say of it that the epidemic was of a severe description. I see no suggestion of mildness in the quality of the small-pox which prevailed. But I see that this epidemic did less mischief than previous epidemics, because comparatively few of the individual members of the Sheffield community had been left without protection (complete or partial) against the prevalent infection.

Deaths "from vaccination" at Sheffield.

I have only one more comment, and this has reference to what may appear an omission from Dr. Barry's report. He says nothing of deaths resulting from the vaccination of 9,000 children each year in Sheffield. As regards the last three years (I have no earlier data), I am able to supply this omission. No death certificate received from Sheffield has made any mention whatever of vaccination. The current rate of the country would give, for a population of 300,000 persons, 0·5 as the yearly number of such death certificates.

No. 6.

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On Small-pox in St. Joseph's Industrial School, Manchester; by Dr. Page.

Report on an Inquiry into the Circumstances of an Outbreak of Small-pox in St. Joseph's Certified Industrial School for Roman Catholic Girls, Manchester; by Dr. Page.

Origin of inquiry.

On August 9th the President of the Local Government Board in answer to a question addressed to him in the House of Commons by Mr. Channing, M.P., as to a reported outbreak of small-pox in St. Joseph's Certified Industrial School, Manchester, stated that the Mayor of Manchester had furnished him with information to the effect that an outbreak of small-pox had been discovered amongst the inmates on Friday July 27th, that 67 of them had been removed to Monsall Fever Hospital, and that the infection was supposed to have been introduced by a girl admitted on July 6th.

The President further stated that the Board had ordered a full inquiry into the circumstances of the outbreak by one of their medical staff.

I was instructed for this duty, and accordingly I visited Manchester on August 10th. At the outset of my inquiry, I had an interview with a sub-committee of the Health Committee of the Corporation, the deputy Town Clerk, and the medical officer of health, Mr. John Leigh.

On the day of my arrival I visited St. Joseph's School, accompanied by Dr. Mackenzie, the recently appointed medical attendant to the inmates, Dr. Oldham, resident medical officer at Monsall Hospital, and Mr. Whiley, superintendent of the Corporation Health Department.

The School.

This school is situated in Victoria Park, a residential suburb of Manchester. It is a large, detached, modern building, three storeys in height, standing within its own grounds of some three acres in extent.

Inmates.

The building has been occupied for its present purpose since 1884, and is certified under the Industrial Schools Act, 1866, for 150 children. Immediately before the outbreak the total number of inmates had been 172, comprising, according to the classification furnished to me by the Lady Superintendent, 10 Sisters, including a probationer, 15 attendants, inclusive of certain pupils* in training for domestic service, and 147 pupils at ages ranging from 5 to 16 years.

Regulations.

In accordance with regulations approved by the Secretary of State for the Home Department, the school is under the management of the Roman Catholic Bishop of the diocese and a committee. The care and education of the children are in the hands of Sisters of the Order of St.

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* Of the attendants, four were paid servants, adults; the remaining 11 were pupils employed in the domestic work of the institution. These 11 are included among the pupils in the rest of the report.

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Vincent de Paul. The regulations require that no girl shall be admitted without a medical certificate of freedom from disease, and it is also a rule of the institution that every girl shall be vaccinated before admission, and a medical certificate to that effect be sent with her. Every Sister must also be vaccinated before entering upon her duties, but there is no such rule for attendants, though in the case of girls who had originally entered the institution as pupils, a certificate of vaccination has presumably been sent.

Medical arrangements.

The regulations state that a medical officer shall be appointed to visit the school, but no provision is made for the medical examination of children on admission, and I was told that no such examination had been made. Dr. Mackenzie, the gentleman who has since been appointed medical attendant, was called in for the first time on July 20th by the Lady Superintendent to see one of the Sisters then ill of what afterwards proved to be small-pox. The connexion with the school of his predecessor in office, Dr. Russell, had ceased on the 30th of June. Between those dates the school was without a medical officer, and no medical visits, as matter of fact, had been made. On referring to a book entitled "The Doctor's Book," provided in accordance with the regulations for the record of visits and serious cases of illness, I found that no entry had been made since May last, and according to medical testimony and the Lady Superintendent, the school has enjoyed a remarkable and complete immunity for years past from outbreaks of infectious disease.

Sanitary arrangements.

The internal arrangements of the institution consist of a common dining room and a large schoolroom on the ground floor, workrooms on the first floor, and dormitories on the uppermost floor. The dormitories of the children are four in number, and so arranged that they communicate directly with one another, the first, or "new" dormitory, alone opening upon the staircase landing, the second, or "middle" dormitory, being entered by crossing an angle of the former, while the third, or "top," and the fourth, or "little," dormitories are reached by traversing the entire length of the "middle" dormitory. The several dormitories thus share in effect one common atmosphere. Each girl has her separate bed, and beds are distributed between the four dormitories thus:—42 in the new, 44 in the middle, 44 in the top, and 20 in the little dormitory. There is no classification of the children save during school hours for teaching purposes, and inmates of various ages along with an attendant occupy each of the dormitories. Additional accommodation is afforded by the infirmary,—a couple of rooms on the first floor, consisting of a small ward of six beds entered through a sitting room, and used for cases of sickness occurring amongst the inmates; and half a dozen of the attendants sleep in a separate building known as the "cottage," but are employed in the institution and associated with the rest of the inmates from 7 a.m. until bedtime.

The children mix together in the playground, chapel, refectory, schoolroom, and elsewhere in the institution.

An examination of the premises as to their sanitary circumstances testified to much care having been bestowed upon the completeness of the arrangements and general hygiene of the school. The cleanliness and order everywhere prevailing, and the comfortable and happy appearance of the children were noticeable features.

Vaccination observed—(*a.*) Among those remaining at school.

On a personal examination of the 99 persons found living in the school at the time of my visits of August 10th and 11th, I found six Sisters and 85 pupils with scars of primary infantile vaccination. In the case of those pupils the results of my own examination accorded with the evidence of the medical certificates presented with the several

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children on their admission. There were also four cases where the facts of primary vaccination were doubtful, and these, with four unvaccinated children, had just undergone successful vaccination.

The four doubtful cases were:—

1. Rosamond Kernagan, aged 10 years. No scars of infantile vaccination visible. No medical certificate. Recent vaccination over usual site for scars.
2. Delia Martin, aged 11 years. No scars visible. No medical certificate. Recent vaccination over usual site for scars.
3. Caroline Duffield, aged 13 years. No scars visible. Medical certificate says, "Doubtful; no scars visible."
4. Kate Stirrup, aged 16 years. No scars visible. Medical certificate states, "Vaccinated, but no scars visible."

The four unvaccinated cases were:—

1. Maggie Cuff, aged 9 years. No scars. No medical certificate. She says she has never been vaccinated. Admitted to the school, 16th September 1886.
2. Hannah Arthur, aged 10 years. No scars. Certificate says, "Not vaccinated successfully." Admitted, 18th March 1888.
3. Annie Stubbs, aged 11 years. No scars. Medical certificate says, "Not been vaccinated." Admitted, 3rd May 1888.
4. Catherine Cullen, aged 9 years. No scars. Medical certificate says, "Unvaccinated." Admitted 8th May 1888.

Re-vaccination has recently been practised on all the vaccinated inmates, unsuccessfully in one Sister and 22 children. Of these unsuccessful re-vaccinations, the Sister and two of the children had undergone successful re-vaccination before July 27th. Of the successful re-vaccinations, two were of Sisters re-vaccinated before July 27th. I found two children, consumptive inmates of the school infirmary, who had been overlooked as to re-vaccination.

(*b.*) Among those removed to Monsall.

Of 73 persons who had been transferred to Monsall Hospital, I found on August 12th, four Sisters and a probationer, three attendants, and 56 children, with scars of successful primary infantile vaccination. One child was undergoing primary vaccination, performed on July 27th. There were also two cases where the facts as to primary vaccination were doubtful; and six persons unvaccinated.*

The two doubtful cases were:—

1. Margaret Waterhouse, aged 9 years. No scars visible. Medical certificate, dated 2nd December 1886, says, "Vaccinated; "scars faintly marked."
2. Mary Jane Maxwell, aged 12 years. No scars visible. Medical certificate, dated 18th March 1887, says, "Vaccination "doubtful; no scars visible."

The six unvaccinated cases were:—

1. Jane Stirrup, aged 15 years. No scars. Medical certificate, dated 26th July 1882, says, "Unvaccinated."
2. Annie Maxwell, aged 14 years. No scars visible. Medical certificate, dated 9th February 1887, says, "Has not had small-pox; has not been vaccinated."
3. Melinda Clewor, aged 14 years. No scars. No medical certificate.

* I myself made examination of 70 of these 73 persons; but in respect of three patients who had died from small-pox in Monsall Hospital, one attendant and two children, I cite the authority of Dr. Oldham, and in one case of the medical certificate, for reporting that they were all unvaccinated.

4. Margaret Woodruff, aged 10 years. No scars. No medical certificate.
5. Maggie Dunleary, aged 13 years. No scars. No medical certificate.
6. Anne Cavanagh (attendant), aged 22 years. No scars.

Of the 73 cases, three, a Sister-probationer, an attendant, and one of the children, had undergone re-vaccination before July 27th.

Re-vaccination had, on July 27th, been performed in 26 of the persons afterwards removed here from the school. It was not performed for those who were ailing already by July 27th. Of the 26 re-vaccinations of July 27th, 21 were successful; of the five unsuccessful cases, four were again re-vaccinated at Monsall on August 3rd, three successfully. And re-vaccination had been performed at Monsall in two other cases on July 31st with successful results.

Small-pox observed—(*a.*) At School.

On the date of my second visit to St. Joseph's School, August 11th, I found one child who had been revaccinated successfully on July 27th suffering under early symptoms of small-pox, but with this exception all the inmates were free from eruptive illness.

(*b.*) At Monsall.

At Monsall, among those who had been removed from the school, I found four Sisters, including a probationer, two attendants, 49 children who had suffered or were suffering under small-pox of one or another degree, and also 15 persons who had been removed from the school for reasons of suspicion, but who had had no eruption of small-pox whatever; the above making, with the three fatal cases, the total number of 73 persons thus removed.

With the exception of six cases removed from the school between August 8th and 11th, and including the case discovered on my visit on the latter date, the outbreak was at an end by July 28th.

The severity of cases that came under my observation varied between the two possible extremes of small-pox. There were cases barely recognisable as such, having only one single pimple or vesicle. At the other extreme there were cases of the confluent disease. Dr. Oldham told me that all the three patients who had died had had confluent eruption, and that one case had been of the hæmorrhagic variety.

Small-pox as influenced by vaccination.

I have now to record, in combination, the facts as to vaccination and small-pox of the whole 172 persons who were in St. Joseph's School on 27th July. This I have done, giving the age of each person, the facts as to the vaccination of each, and the facts as to the occurrence of small-pox in each, in the annexed table.

FACTS as to 172 PERSONS, INMATES of ST. JOSEPH'S SCHOOL on July 27th, showing their previous VACCINATION and the ATTACKS of SMALL-POX among them, during July and August 1888.

Individuals classified according to their Vaccination and their Small-pox.		Not vaccinated before 27th July.	Vaccination before 27th July doubtful.	Bearing Scars of Infantile Vaccination, but not re-vaccinated before 27th July.	Successfully re-vaccinated before 27th July.
Classified below as to Small-pox. Total being **172**		Ten persons (their ages shown by figures below.)	Six persons (aged as below).	A hundred and forty-eight persons (their ages shown by figures below).	Eight persons (aged as below).
Escaped small-pox -		14, 11, 10, 9, 9	16, 13, 11, 10	50*, 40*, 27*, 23*, 16, 16, 16, 16, 16, 16, 16, 16, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 14, 14, 14, 14, 14, 14, 14, 14, 14, 14, 13, 13, 13, 13, 13, 13, 13, 13, 13, 13, 13, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 11, 11, 11, 11, 11, 10, 10, 10, 10, 10, 10, 10, 10, 9, 9, 9, 8, 8, 8, 8, 7, 7, 7, 7, 6, 6, 5, 5	36*, 30*, 29,* 28*, 16, 14, 13
	113	**5**	**4**	**97**	**7**
Had slighter small-pox. viz. :— With from one to fifty spots.	**41**	— **0**	— **0**	39*, 23*, 23*, 18*, 16, 16, 16, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 15, 14, 14, 14, 13, 13, 13, 13, 13, 12†, 12, 12, 12, 12, 12, 12, 12, 11, 10, 10, 10 **40**	22* **1**
Had slighter small-pox. viz. :— Discrete, with more than fifty spots.	**8**	— **0**	— **0**	16, 15, 15, 15, 12, 12, 12, 11 **8**	— **0**
Had severer small-pox. Semi-confluent	**5**	— **0**	12, 9 **2**	14, 14, 13 **3**	— **0**
Had severer small-pox. Confluent -	**5**	*22 (died), 15 (died), 14, 13 (died), 10 **5**	— **0**	— **0**	— **0**

* Sisters and attendants are thus distinguished,*.
† Conley, the child attacked on 6th or 7th July.

Except for the names of individuals and the days of their respective attacks, this table gives every fact of any importance to the inquiry; viz., for each person, her age; vaccination, non-vaccination, or re-vaccination; her escape from small-pox or the nature of the small-pox that attacked her; together with her status in the school. I hand in the records of the several cases, but see no object in printing them in this report.

In brief the table shows—out of 172 persons exposed to the conditions of the school up to the day of small-pox being detected and of the general re-vaccination—10 who had never been vaccinated, of whom five took the infection of small-pox, and five escaped it*; six whose vaccination was doubtful, of whom two contracted the disease and four escaped*; 148 persons who had been vaccinated in infancy, of whom 51 contracted the disease, and 97 escaped it*; along with, lastly, eight who had been re-vaccinated some months or years before, of whom one (it is believed) was attacked while the other seven escaped.

The table also shows the degree of severity of the disease in the several cases which, with the escapes, may be summarised, as follows:—

1. Of those unvaccinated up to July 27th, 10 in number, five escaped small-pox, and five suffered from confluent attacks, of whom three died.†
2. Of those with doubtful vaccination on this date, six in number, four escaped attack, and two suffered from semi-confluent attacks, not fatal to either.
3. Of those vaccinated before the same date, 148 in number, 97 escaped attack, 40 were attacked in whom the eruption consisted of from one to 50 spots, eight were attacked with discrete eruption of over 50 spots, and three with semi-confluent small-pox. Among the 51 persons of this class attacked by small-pox, there was no death.
4. Of eight persons re-vaccinated before July 27th, one is believed to have been attacked; she had only a single spot.

History of outbreak.

In proceeding to give a history of the outbreak, I have first to recall the fact that from June 30th to the 20th of July the school was without a medical officer. On the latter date Dr. Mackenzie was asked to see one of the Sisters, Sister Clare, who was then ill. I saw Sister Clare at Monsall Hospital on 12th August, when she was quite recovered from her illness, of which she gave me the following account. On Friday July 13th she had an attack of headache, accompanied on the two following days by sickness and vomiting. On Monday July 16th she felt better and resumed her place in school, teaching the younger children. Sister Clare told me that she is subject to periodical attacks of neuralgic headache and sickness, and that she had regarded this attack as being one of these. On Tuesday July 17th she was seized with headache, sickness, severe pain in the back and abdomen, accompanied by diarrhœa, symptoms which she described as being quite different from her customary attacks. "She had not been ill like that "before." She was confined to bed in her dormitory until July 20th,

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* I recall, in connexion with these several groups of escapes, the general vaccination and revaccination of July 27.

† 1. Anne Cavanagh, aged 22, attendant, died 5th August
2. Maggie Dunleary, aged 13, pupil (hæmorrhagic), died 9th August.
3. Jane Stirrup, aged 15, pupil, died 10th August.

when she felt no better, and the doctor was accordingly sent for. Dr. Mackenzie explained to me that on his first visit he found Sister Clare suffering from what appeared to be a "bilious attack," with no apparent feverishness. He saw her next day, the 21st, again on the 23rd, when she expressed herself as feeling a little better, and not again until the 25th, when for the first time, either to patient or doctor, I am told, a few spots became visible upon Sister Clare's face. But the sickness and backache had gone, slight headache alone remaining, so that, except for other cases of sickness which were meanwhile occurring in the school, his suspicions that it might prove to be a case of small-pox would not have been aroused. On the evening of the same day a rash, Sister Clare informed me, appeared on her arms, and it disappeared next morning. On Friday July 27th a further eruption of spots was discovered upon her body, leaving, when Dr. Oldham saw them on that date, no room for doubt as to the nature of the disease. On Monday July 23rd Dr. Mackenzie had been asked to see four or five children whom he found in bed, complaining of headache, pain in the stomach, and vomiting. The Lady Superintendent stated that so early as the 19th there had been a case or two of slight indisposition amongst the children, but that these and other cases occurring up to the 23rd were treated with domestic remedies and looked upon as the result of some indulgence in pastry at an entertainment which was given to the children upon the earlier date. Fresh cases of sickness occurred on the following day, and others on the 25th and 26th, by which latter date 24 of the inmates were upon the sick list. These facts, together with the sickening of another Sister and an attendant, confirmed the suspicion which Dr. Mackenzie had begun to entertain, that the spots he found upon the various inmates might really be small-pox; and he paid an early visit on Friday, 27th July, to find some 20 additional cases of sickness reported to him. He proceeded forthwith to the Town Hall, and communicated his fears to the Authority that small-pox had broken out among the inmates of St. Joseph's School. Dr. Falconer Oldham, Medical Superintendent of Monsall Hospital, was at once requested to visit the school on behalf of the Corporation. Dr. Oldham found a large number of the inmates suffering either from small-pox or from symptoms suspected to be premonitory of the disease. Instructions were given by the Health Committee for the immediate removal of all such inmates, and in the course of the evening 46 persons were taken to Monsall. Dr. Mackenzie proceeded with the re-vaccination of the remaining inmates, and under the direction of Mr. Whiley, of the Health Department, disinfection of the dormitories and removal of the bedding to the Corporation disinfecting chambers was carried out by a large staff of assistants. Next day July 28th a further examination of the inmates led to the removal to Monsall of other 20 persons, and on July 31st another of the inmates was sent there, making 67 persons, including three Sisters, five attendants, and 59 children removed by the end of July.

Dr. Oldham reported that amongst this number he discovered on 27th July one case already convalescent from small-pox, still exhibiting, however, traces characteristic of the disease in the form of a scattered eruption of spots upon which were still adherent horny scabs or scales. This case was the girl, Mary Anne Conley, admitted to the school from York on July 6th. Dr. Oldham described the whole of the remaining cases as being of much more recent date, some presenting merely suspicious symptoms, while others exhibited the eruption of small-pox in the papular or vesicular stage, in one or two cases only advanced to pustules. Dr. Oldham told me that in Sister Clare's case he found the

vesicles, seven or eight in number, upon the face, beginning to dry without passing into pustules.

Taking into consideration the ordinary incubative period of small-pox, 14 days to the period of eruption, and the succession of cases from the date of Sister Clare's attack until the 28th of July, it is obvious that an outbreak showing the above dates cannot be accounted for by a series of infections from case to case, but that it must have been dependent upon the operation of a single source of contagion to which those attacked had, in common, been exposed.

Importation.

It is easy enough to account for the half dozen later cases occurring between August 8th and 11th with which the outbreak ended, for these in all probability contracted infection by personal intercourse with infected inmates with whom these later cases had been unrestrictedly associated before the removal of them to Monsall on July 27th and 28th.

In regard, therefore, to the origin of this outbreak and the mode of introduction of infection into the school, I made inquiry in the first instance into all movements of the inmates beyond its walls. I was told that such movements were, in the case of the pupils, confined to attendance every Sunday morning at the neighbouring church of St. Edward, Rusholme, whither they are taken in detachments; that none of the attendants had been away from the institution during the latter half of June or beginning of July, and that, save for purposes of shopping, none of the Sisters had been in Manchester during the same period, Sister Clare informing me she had not been in the city for any purpose since some time in May last.*

I inquired as to the possibility of infection by clothing, but it was shown to me that the clothes of the children are made upon the premises from new material, and I was told that it is an invariable practice on the admission of a pupil to destroy in the kitchen furnace every article of apparel she brings with her. Every child is provided with a new outfit, no worn clothing is accepted by way of gift, and all needlework is wrought upon new material.

In view of a possible introduction of infection by children or others recently admitted to the institution, I directed my inquiry to the history of every one who had entered it between the middle of June and the middle of July. These admissions were stated by the Lady Superintendent to have been altogether six in number, and included five children admitted from Manchester on June 21st, 22nd, 26th, July 1st and 11th, and a child admitted from York on July 6th.

Of the Manchester cases, two were homeless waifs picked up in the streets by the local school officers. I visited the homes of other two, accompanied by Mr. Whiley of the Health Department, where, as well as at houses around, I made inquiry and examined children with the result of finding no evidence of the existence of small-pox of any description; and the fifth case was a girl admitted from Crumpsall workhouse, in whose case there was no history of antecedent illness.†

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* It may be well to state explicitly that the Sisters do no visiting amongst the poor, but are wholly engaged in the care and education of the children in St. Joseph's School.

† During the same period covered by this part of the inquiry, three cases only of small-pox had been notified to the health authorities at Manchester, on June 15th, 19th, and 29th, when they were removed to Monsall. No further cases were notified prior to the outbreak at St. Joseph's School, and throughout August the only notification received was of the later cases that occurred in connexion with the school outbreak.

I examined the five Manchester children without finding any indications of illness prior to admission. All had been successfully vaccinated in infancy, and all had escaped small-pox save one, who had been attacked on July 27, and was seen by me at Monsall.

The girl from York.

With regard to the sixth child, admitted as stated from York on July 6th, I saw her in the wards at Monsall on August 12th, when she was running about and helping to wait upon those who were still confined to bed. This child, Mary Anne Conley, nearly 13 years of age, showed, upon examination, three vaccination scars of well-marked characters, but of small area. I observed, scattered over her feet, legs, and arms, about a dozen spots, two or three more upon the body and a single one upon the face, the whole number not exceeding 20. Several were mere stains or discolorations, but the majority were distinct, although not deep, depressions of a bluish-red colour, the spot upon the face being red and more deeply pitted than the rest. I noticed no adherent scabs or scales, but both the medical superintendent and the ward nurse stated that these were to be seen after the child's admission on July 27th, and that they were similar in appearance to what are seen in the later stages of modified small-pox. I questioned the girl with the view of eliciting her history, but her discrepant statements inducing me to make a subsequent visit to the hospital for the purpose of cross-examining her, I found her story from beginning to end hopelessly contradictory, and in material points the child admitted her previous statements to be untrue.

I visited York on August 14th, when I had an interview with the Town Clerk, Mr. McGuire, and Dr. North, medical officer of health, from whom I received most cordial assistance at this stage of my inquiry.

I visited the locality in Hungate, where the child lived prior to her removal to Manchester, and saw her mother, sisters, and other persons with whom she had been most intimately associated up to the day she left. I also saw the school attendance officer who accompanied her from York to Manchester, and I was enabled to find their fellow passengers on the journey.

I may state at once that the evidence is complete and conclusive that Mary Ann Conley was duly examined and truthfully certified on July 3rd to be free from disease, and that on July 6th, the day of her removal from York, she continued to be to all appearance in good health and free from recognisable symptoms of illness up to the time of her reception at the school. This case has become matter of dispute between York and Manchester, but without, so far as I can see, the smallest occasion. The facts about the child are perfectly clear and intelligible. She was found on examination before her journey to be from small-pox eruption. There is evidence that she had no noticeable eruption when on the journey. She was found, on examination, to be free from eruption on her arrival at the school. She began to be ill the night of her arrival with slight symptoms, which were shown by the events to be those of small-pox. I have data for all these statements, and place them among the Board's records without entering upon them here.

It only remains now to consider the relations of Mary Ann Conley to the outbreak with which she has been associated, and of which she is believed to have been the origin.

The absence of evidence of exposure to contagion of small-pox in York, the want of medical observation of the three days' illness with which the child's school life at St. Joseph's, Manchester, immediately began, and the blank in her subsequent history until her case was recognised by Dr. Oldham on July 27th as being one of mild, modified, small-pox in the stage of recovery, are important omissions in the circumstantial evidence of the case. But the early illness of Sister Clare, who had early concern with the child on her reception into the school; of Sister Monica, the superintending sister, who had much to do with the child soon after her reception; and the next earliest occur-

rences of small-pox amongst those who were most intimately associated with her, and sleeping in the same dormitory (*e.g.*, a little York girl, Maggie Rafter, who became her companion at the outset), constitute a sequence of events, intelligible only on the hypothesis that her obscure illness on July 6th to 8th was veritable small-pox, capable of infecting other people exposed on these and subsequent occasions to her companionship.

The absence of any indications of the duration of the eruption on this child is of less moment. It was not present on July 6th, it had advanced to scabbing by July 27th, and between those dates it must have appeared early enough to go through the successive changes leading to scabbing and cicatrization in which later stages Dr. Oldham found it.*

It is clear that the phenomena of disease in this child preceded by a distinct and appreciable interval the whole of the other events of the outbreak.

If the child was, as she appears to have been, in York during a period of at least several weeks prior to the removal to Manchester, she must have caught, although in what manner cannot be learned, her infection there. No small-pox had been known to exist in the city itself for a considerable interval, but two cases had been brought for treatment into the city fever hospital, one on June 14th and the other on June 23rd from the militia camp in the surrounding country district. The statements of the girl herself regarding her movements cannot be believed, for she was admittedly a truant and was proved to be untruthful.

Before leaving Manchester I had an interview with Mr. Richardson, secretary to the committee of the school, and made the following recommendations for the future better administration of the institution :— Advice to school authorities.

1. Enforcement of the rule requiring the production of a medical certificate with every child on admission.
2. Vaccination of every child without scars of successful vaccination, and re-vaccination of all children upon reaching 10 years of age.
3. Provision for medical supervision of the inmates, and particularly in cases of illness, no matter how trivial, occurring in recently admitted children.
4. Provision of a probationary ward or small sanatorium detached from the main building in which cases of illness suspected to be of infectious character could be isolated.

Mr. Richardson promised that my suggestions should receive the careful attention of the committee.

The lesson taught by this outbreak is of twofold application :—

In the first instance it demonstrates the result of having no medical officer charged with the duty of supervising the health conditions of an institution, and of the neglect of rules which apparently from long immunity from infection in the school had been allowed to fall into abeyance.

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* I am told by the Sisters that the incidence of attacks upon the several dormitories on 28th July had been as follows :—

	Beds.	Attacks.
New Dormitory (Conley's)	42	26
Middle	44	16
Top	44	11
Little	20	6

I am not disposed to attach much, if any, importance to a statement made to me on August 14th by one of the attendants to the effect that she recollected seeing a spot on Conley's face on one of the days when she was ill. This attendant omitted all mention of this fact when I first questioned her on August 12th.

And secondly, it repeats the long known experience as to the infectiousness of the most trivial cases of small-pox, and the consequences of ignoring this experience.

Marson writing on small-pox says in regard to the infectious nature of the disease:—"Most likely it is communicable from the moment "when the initiatory fever begins. It may be given by the breath of "the patient before the eruption has appeared on the surface of the "body," and further, as regards the relation of the infecting source to the resulting disease, "a mild case may, and often does, give rise to a "severe one, and, on the contrary, a severe case may produce a mild "one."*

* Reynolds' System of Medicine, vol. I., p. 451, 1866.

ADDENDUM.

Analysis of table on page 56, showing for St. Joseph's School, during July and August, the number of Small-pox Attacks (whatever their intensity) upon vaccinated and unvaccinated persons of different ages; influence of the general vaccine operations of July 27th not being taken into account.

[There are no children under 5: eight re-vaccinated persons whose infantile vaccination was doubtful are not here considered. Fatal attacks are indicated by figures in brackets.]

Inmates at subjoined Ages.	Vaccinated in Infancy.			Unvaccinated.		
	Total.	Attacked.	Attacks p.c.	Total.	Attacked.	Attacks p.c.
5-10 years	15	0	0·0	2	0	0
10-15 „	82	28	34·0	6	3 [1]	50
15-20 „	44	20	45·5	1	1 [1]	100
Over 20 „	7	3	42·9	1	1 [1]	100
All ages	(†)148	Attacks 51 Deaths 0	34·5 0·0	10	Attacks 5 Deaths 3	50 30

So that, under the circumstances of this school, these 148(†) persons should have had 23 more attacks, and should have experienced 44 or 45 deaths from small-pox, if the 148 had been in the same case with the ten who were unvaccinated.

No. 7.

Abstract of Medical Inspections made in 1888 with regard to the Incidence of Disease on particular places, and to questions concerning Local Sanitary Administration.

1. Ashbourne (Derbyshire); population (1881), 3,845; Dr. Bruce Low.

   Sanitary Authority: Ashbourne Local Board, U.*

   Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

   Chief Facts reported: Diphtheria suddenly epidemic. Origin uncertain. Diphtheria deaths for a while registered as "Croup." Disease spread apparently by children attending national infants' school. *See* p. 75 of present volume.†

2. Aylesbury (Bucks); population (1881), 7,795; Mr. Spear.

   Sanitary Authority: Aylesbury U.

   Ground of Inquiry: Continued prevalence of diphtheria.—Local requests.

   Chief Facts reported: An epidemic of diphtheria (reported upon by Dr. Gresswell) lasting from October 1885 to the end of March 1886. Recurrence of diphtheria in April 1887; continued, but comparatively moderate, prevalence until November, when,—as in November 1885,—an epidemic outburst of the disease. *See* p. 107 of present volume.‡

3. Berwick-upon-Tweed; population (1881), 13,998; Dr. Page.

   Sanitary Authority: Berwick-upon-Tweed U.

   Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

   Chief Facts reported: Endemic throat illness, the mortality from which formerly registered for most part as "croup," has been in recent years more commonly referred to "diphtheria." Unusual incidence of fatal attacks upon infants; but data as to prevalence of non-fatal throat illness imperfect.

   Hospital provision available, but not made use of.

   Water supply deficient in Spital and Tweedmouth portions of district.

   Sewers unventilated in Berwick, deficient in Tweedmouth; no system of sewerage in Spital. Some overcrowding of dwellings.

4. Bridgend Registration District (Glam.); population (estimated), 44,130; Mr. Spear.

   Sanitary Authorities: Bridgend U. and R.,* Cowbridge U., Maesteg U., and Ogmore and Garw U.

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* Throughout this abstract "R." denotes "Rural Sanitary Authority," and "U.," "Urban Sanitary Authority."

† Report reprinted as App. A. No. 8 of present volume.

‡ Report reprinted as App. A. No. 13 of present volume.

Ground of Inquiry: Necessity of further information as to administration of these sanitary districts, and especially as to arrangements for performance of the duties of Medical Officer of Health.

Chief Facts reported: Five Poor-Law Medical Officers act as Medical Officers of Health for their respective divisions of the rural district, each at a merely nominal annual remuneration: each of the four urban districts has its own Health Officer. No official communication or concerted action between these several officers.

The sanitary administration and condition of the Registration District extremely unsatisfactory in several important respects: —Sewerage defective or entirely absent; water supplies exposed to pollution; methods of excrement disposal and removal giving rise to nuisance; much house property damp, dilapidated, and ill-ventilated, and in places altogether unfit for habitation.—No efficient means of isolation or disinfection.* *See* p. 343 of present volume.

5. Buckingham (Bucks); population (1881), 3,585; Dr. Parsons.

Sanitary Authority: Buckingham Town Council, U.

Ground of Inquiry: Local information of outbreak of enteric fever, and requests for inspection.

Chief Facts reported: A sudden outbreak of enteric fever in January and February 1888, confined at first to a poor suburb of the town, and specially affecting persons drinking water from a particular "spout." The water-conduit to this spout exposed to pollution from a leaky drain which had received specifically infected excreta from a previous case of enteric fever. Later on, scattered cases of fever in other parts of the borough, referable in all probability to infection derived from defective drains and foul closets.

Sewers and house drains very defective, allowing deposit, leakage, and entrance of drain air into houses. Old privies with large deep vaults; hopper-closets often foul from insufficient flushing. Defective indoor w.c.'s in the larger houses. Many old cottages deficient in garden or yard space; damp, ill-ventilated, and overcrowded. Water, generally from wells, exposed to risk of pollution by leakage from cesspools, drains &c. No byelaws. No isolation hospital.

6. Camelford Rural Sanitary District (Cornwall); population (1881), 7,605; Dr. Ballard.

Sanitary Authority: Camelford R.

Ground of Inquiry: Diphtheria.—Registrar-General's Returns and Report of Medical Officer of Health.

Chief Facts reported: Unusual prevalences ince 1884 of diphtheria chiefly in Camelford Registration Sub-District and in neighbourhood of Delabole slate quarries. Diphtheria deaths habitually registered as "Croup." General negligence of sanitary administration. Sanitary Authority insufficiently advised by Medical Officers of Health. *See* p. 99 of present volume.†

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* Report reprinted as App. A. No. 20 of present volume.
† Report reprinted as App. A. No. 12 of present volume.

7. Cleator Moor (Cumberland); population (1881), 10,420; Dr. Page.

Sanitary Authority: Cleator Moor U.

Ground of Inquiry: Prevalence of infectious diseases, especially in relation to school attendance.—Reports of Medical Officer of Health.

Chief Facts reported: Concurrent prevalence of scarlatina and measles in a mining and colliery population. Spread of both diseases by personal intercourse, abundant opportunities for which existed apart from school attendance. Influence of the latter apparently marked in regard to measles but undetermined as to scarlatina.

9. Congleton (Cheshire); population (1881), 11,116; Dr. Page.

Sanitary Authority: Congleton U.

Ground of Inquiry: Report by Medical Officer of Health of deaths from "epidemic pneumonia."

Chief Facts reported: Acute pneumonia of the ordinary so-called idiopathic form prevalent to an unwonted degree between March 1887 and the end of January 1888, causing 19 deaths. The disease, which attacked all ages, and was fatal to both infants and adults, had been prevalent also in surrounding country districts.

10. Dingestow Registration Sub-District (Monmouth); population (1881), 14,920; Mr. Spear.

Sanitary Authority: Monmouth R.

Ground of Inquiry: High mortality from diphtheria.—Registrar-General's Returns.

Chief Facts reported: Fifteen families invaded by diphtheria; 30 cases and seven deaths between September 1887 and February 1888. In addition, some 12 cases in seven families of severe sore-throat, the specific nature of which was not clear. Origin of the disease not determined; adult attacks disproportionately large; disease apparently spreading by other means than personal infection.

11. Dolgelly (Merioneth); population (1881); 2,455; Dr. Parsons.

Sanitary Authority: Dolgelly Local Board, U.

Ground of Inquiry: High death-rate.—Reports of Medical Officer of Health.

Chief Facts reported: High general death-rate, chiefly due to the unusually large proportion of elderly persons among the inhabitants, but probably increased by the defective sanitary condition of dwelling-houses. Infant mortality, and that from phthisis, lung, and heart diseases, large. Zymotic death-rate small.

Town in a damp and comparatively sunless situation, shut in by hills. Many houses deficient in space, both without and within; also damp, dilapidated, and ill-ventilated: overcrowding. Local byelaws as to new buildings and other matters entirely disregarded. Sewers on the whole fairly satisfactory.

Older house drains of defective construction. Excrement disposal by water-closets, many of which are unprovided with water; as a consequence closets frequently out of order and in filthy state. Yards ill-paved; neglect of surface cleanliness. Good public water supply from lake, but pressure in many parts of town insufficient, and service not universal. A public slaughter-house, but ill-kept. Sanitary administration lax. No isolation hospital or disinfecting apparatus.

12. Enfield (Middlesex); population (estimated) 23,000; Dr. Bruce Low.

Sanitay Authorities: Enfield Local Board, U., and Edmonton U.

Ground of Inquiry: Diphtheria epidemic.—Local complaint.

Chief Facts reported: Diphtheria more or less prevalent in district for some years. Epidemic in October 1888. Extension of disease at that time connected with a particular infants' school. In December epidemic diphtheria invaded better class houses in Enfield suburbs which had not suffered before; disease here distributed by a particular milk supply. After Christmas holidays Central Enfield again suffered diphtheria in its poorer population, particularly among attendants at a second set of schools, which were accordingly closed. Diphtheria observed in domestic animals, especially in cats. *See* p. 123 of present volume.*

13. Exmouth (Devon); population (1881), 6,245; Dr. Parsons.

Sanitary Authority: Exmouth Local Board, U.

Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

Chief Facts reported: Outbreak of diphtheria in first half of 1888, especially among the working class and in a low-lying part of town. Origin not traced. Propagation by personal intercommunication at school and at home. Associated where most prevalent and fatal with conditions leading to contamination of air in and around houses by effluvia from sewers and drains.

Sewers of flat gradient and tide-locked, favouring deposit, and emission of offensive gases. Many ventilators closed owing to complaints of stench from them. House drains inefficiently trapped.

14. Fareham Registration District (Hants); population (1881), 16,931; Mr. Spear.

Sanitary Authorities: Fareham U. and R.

Ground of Inquiry: Diphtheria and enteric fever.—Registrar-General's Returns and local complaint.

Chief Facts reported: (1.) *Fareham R.*—An intermittent prevalence of diphtheria in the hamlets of Swanwick and Sarisbury for 1½ years. During this period, re-appearance of the disease, after an interval of apparent freedom, on five separate occasions. Diphtheria attaching itself especially to one of the two Elementary schools. On four occasions fresh manifestation of the disease amongst the pupils upon the re-opening of the school after intervals of closure of 2, 5, 6, and 13 weeks respectively. Small disposition as a rule of diphtheria to spread in the

* Report reprinted as App. A. No. 14 of present volume.

houses of the sufferers; in exceptional instances only, notable extension. No apparent connexion between severity of attack and infectiousness of developed malady. Sanitary condition of implicated school very unsatisfactory; amongst other defects, part of the foundations found to be sewage-sodden.

(2.) *Fareham U.*—Smart outbreak of diphtheria in little outlying hamlet of Fontley in last half of 1888. Origin of first case obscure, but occurring in house immediately adjoining one invaded by diphtheria 18 months previously. Water supply polluted, houses damp and two overcrowded.

Epidemic of typhoid fever in summer of 1885 in town of Fareham, attributed by Medical Officer of Health to pollution of an intermittent water supply through numerous direct connexions between water mains and closet pans. This then remedied, and a "constant" supply of water afforded. Enteric fever has since been less prevalent in the town.

15. Flint (Flintshire); population (1881), 5,096; Mr. Spear.

Sanitary Authority: Flint U.

Ground of Inquiry: Information of fever outbreak from local sources.

Chief Facts reported: The disease true enteric fever although certain circumstances had suggested typhus. Fourteen cases in seven households; six of the seven infected between August 11th and August 20th. The fever subsequently general over the town, under circumstances pointing rather to the water supply as the cause. Water supply intermittent, and in specially infected locality allegation of discolouration of the water when turned on in the morning. Method of excrement disposal in infected locality such as to cause fœcal fouling of air and soil. Many houses scarcely fit for habitation. A public room opened as a temporary hospital.

16. Holme Cultram Urban Sanitary District (Cumberland); population (1881), 4,230; Dr. Parsons.

Sanitary Authority: Holme Cultram Local Board, U.

Ground of Inquiry: Insufficient reports of Medical Officer of Health.

Chief Facts reported: Silloth.—A seaport and watering place of modern date, well laid out and sewered. Water supply for flushing of w.c.'s accumulated in rainwater cisterns; insufficient in dry weather. Drinking water from wells in the gravel bed on which the town stands. This water shown by analysis to be more or less contaminated by organic products.

Other parts of district purely rural with a scattered agricultural population. Many old cottages dilapidated, damp, and ill-ventilated; some deficient in privy accommodation and in yard space or garden. Overcrowding. Slop-water nuisances. Water supply from wells, often liable to contamination; some houses without water supply. No building byelaws. Common lodging-houses and slaughter-houses not regulated in accordance with byelaws.

17. Keynsham Rural Sanitary District (Somerset and Gloucestershire); population (1881), 25,781; Dr. Blaxall.

Sanitary Authority: Keynsham R.

Ground of Inquiry: Enteric fever.—Registrar-General's Returns and local complaint.

Chief Facts reported: Recurring prevalence of epidemic disease. Enteric fever conveyed, in the bodies of persons attacked by it, from one part of the district to another; spread of the disease by specific excremental pollution of water. Incidence of mortality from measles and whooping cough upon Oldland and Bitton, and of typhoid fever upon Keynsham. Neglect of Sanitary Authority to carry out their duties under the Public Health Acts. No isolation hospital provision, and no efficient steps taken to prevent the spread of disease. No proper provision of sewerage; villages dependent upon old highway sewers utterly unfitted for the purpose, for removal of sewage: cesspit privies in vogue. Water supplies exposed to dangerous pollution, and at places scanty in quantity. [Water recently introduced into district from extraneous sources by the West Gloucester Water Company.] Dairies and cow-sheds not registered. Inspection of district not carried out by the Medical Officer of Health or Inspector of Nuisances.

18. Kilkhampton (Cornwall); population (1881), 975; and neighbourhood; Dr. Parsons.

Sanitary Authority: Stratton R.

Ground of Inquiry: Diphtheria.—Request of Chairman of Rural Sanitary Authority.

Chief Facts reported: Sustained prevalence of diphtheria in Kilkhampton and neighbourhood, more severe and fatal in outlying farmhouses and cottages than in the village itself. Origin of disease unknown, spread probably chiefly by personal intercourse. The diphtheria preceded and accompanied by a prevalence of sore-throat, not presenting specific characters. Occasionally diphtheria associated with scarlet fever. *See* p. 89 of present volume.*

19. Llandissilio Registration Sub-District (Pembrokeshire); population (1881), 3,334; Mr. Spear.

Sanitary Authority: Narberth R.

Ground of Inquiry: Prevalence of diphtheria.—Registrar-General's Returns.

Chief Facts reported: Three isolated cases of diphtheria in village of Llandissilio and neighbourhood during latter part of February and early part of March 1888, followed between 18th and 25th of the month by invasion of 14 out of 72 houses in adjoining villages of Llandissilio and Clynderwen; 22 fresh cases occurring during these eight days. Attacks almost exclusively confined to children, but no special incidence upon school attendants. No incidence upon consumers of any special food-stuff, nor any evidence, in the epidemic outbreak, of infection from domestic animals.

Sanitary condition of villages in question exceedingly unsatisfactory. Sewage nuisances universal; water supplies polluted; many cottages so damp, dilapidated, and ill-provided as to be unfit for habitation.

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* Report reprinted as App. A. No. 10 of present volume.

Transmission of the disease from infected villages to others; once clearly by a visitor, and once apparently by dogs (terriers), which became ill while frequenting the infected houses.

20. Llanwddyn (Montgomeryshire); population (estimated), 1,453; Dr. Parsons.

Sanitary Authorities: Llanfyllin R. and Liverpool Corporation.

Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

Chief Facts reported: Outbreak of diphtheria in spring and summer of 1888 at Llanwddyn, a village in a shut-in valley about to be converted into reservoir of Liverpool Waterworks. Origin of disease not ascertained, first cases not recognised as diphtheria. The epidemic at first confined to the old village, and to people attending the church, afterwards extending to workmen's huts, and other parts of parish. Diphtheria preceded and accompanied by prevalence of tonsillitis, and other forms of sore-throat.

21. Lower Brixham (Devonshire); population (estimated), 6,000; Dr. Blaxall.

Sanitary Authorities: Lower Brixham Local Board, U., and Totnes R.

Ground of Inquiry: Prevalence of Scarlatina.—Local request for inspection.

Chief Facts reported: Widespread and long-continued epidemic of scarlatina. Disease kept up and spread by unrestricted personal communication between infected and healthy. Schools playing an important part in the dissemination. Schools closed only after the disease had become epidemic. No means of isolation, or disinfection of infected clothing. *See* p. 153 of present volume.*

22. Middlesbrough (Yorks); and the neighbouring Sanitary Districts; population (1881), 71,367; Dr. Ballard.

Sanitary Authorities: Middlesbrough Town Council, U., and Eston, Normanby, and Ormesby U.

Ground of Inquiry: Continued prevalence of "pneumonia" reported by Medical Officer of Health of Middlesbrough.

Chief Facts reported: Pneumonia epidemic lasting from the end of January to about the middle of July 1888; and causing during 24 weeks of its continuance, in three out of four districts referred to, mortalities ranging from 30 to 40 per 10,000 of the population. *See* p. 163 of present volume.

23. Midsomer Norton (Somersetshire); population (1881), 4,420; Dr. Blaxall.

Sanitary Authority: Midsomer Norton U.

Ground of Inquiry: Diphtheria.—Report of Medical Officer of Health.

Chief Facts reported: Smart outbreak of diphtheria amongst children attending the chapel school preceded by cases of sore-

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* Report reprinted as App. A. No. 17 of present volume.

throat and diphtheria in this school. Children from infected houses permitted to attend school; one child returned to school while in an infectious condition. Antecedent prevalence of diphtheria in adjoining parishes, and probable connexion therewith of the throat illness in Midsomer Norton. *See* p. 93 of present volume.*

24. Mytholmroyd (Yorks, W.R.); population (estimated), 2,270; Dr. Page.

Sanitary Authorities: Hebden Bridge, Sowerby, and Midgley U., and Todmorden R.

Grounds of Inquiry: Prevalence of enteric fever and sanitary administration.—Reports of local Medical Officers of Health.

Chief Facts reported: A village of upwards of 2,000 inhabitants on the banks of the Calder, extending into the areas of jurisdiction of four separate Sanitary Authorities. Pollution of Calder by sewage of towns higher up its course. Faulty water supply, sewerage, and excrement disposal. Defective sanitary administration resulting from divided authority in the place. *See* p. 335 of present volume.†

25. New Brighton (Cheshire); population (estimated), 15,545; Mr. Spear.

Sanitary Authority: Wallasey U.

Ground of Inquiry: Local complaints respecting the alleged occurrence of enteric fever around a certain slaughter-house.

Chief Facts reported: Slaughter-house in question situated in the most populous and least elevated part of New Brighton, a sea-side resort of the poorer class. Enteric fever not more common in New Brighton than in other parts of the urban district; but tendency to the recurrence of the disease in the *low lying* part of it; especially in certain spots, one of which is in the neighbourhood of the particular slaughter-house. Fever due in all probability to the condition of public sewerage and private drainage, which in the low-lying area, and especially as regarded the houses invaded, was found to be markedly defective. *See* p. 141 of present volume.‡

26. New Clee; population (estimated), 17,000; and Great Grimsby; population (1881), 28,600; Dr. Page.

Sanitary Authorities: Clee-with-Weelsby U., and Great Grimsby Town Council, U.

Ground of Inquiry: Prevalence of enteric fever.—Registrar-General's Returns.

Chief Facts reported: Enteric fever, which attacked 88 households from February 1887 to April 1888, causing 31 deaths, associated with local unsanitary conditions of a persistent sort, and common to both districts. *See* p. 133 of present volume.§

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* Report reprinted as App. A. No. 11 of present volume.
† Report reprinted as App. A. No. 19 of present volume.
‡ Report reprinted as App. A. No. 16 of present volume.
§ Report reprinted as App. A. No. 15 of present volume.

27. Norwich (Coslany Registration Sub-district); population (1881), 14,193; and "Rackham's Field" (Norfolk); Dr. Airy.

Sanitary Authorities: Norwich Town Council, U., and St. Faith's R.

Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

Chief Facts reported: Severe outbreak of diphtheria in 1887–88, beginning in "Philadelphia," a somewhat elevated suburb of Norwich, at the head of one of the two main sewer-systems, and extending into the adjoining Rural District (St. Faith's). Origin of disease uncertain. Spread of infection chiefly among children attending the Philadelphia Board School and many others having personal communication with them. Water supply principally from wells not far from privies, but yielding on analysis no certain evidence of pollution; and partly from the city waterworks. Isolation hospital (of iron) unsatisfactory, almost useless.

28. Queen Camel (Somerset); population (1881), 542; Dr. Parsons.

Sanitary Authority: Wincanton R.

Ground of Inquiry: Diphtheria.—Local information.

Chief Facts reported: Village previously inspected by Dr. Parsons on account of outbreak of diphtheria in autumn of 1885. Another outbreak of diphtheria in winter of 1887–88. Spread of disease explicable by personal communication at school and elsewhere. Special incidence of the disease on houses on the course of one particular sewer; gross unsanitary conditions at the houses invaded. No action taken since previous inspection in 1886.

29. St. Austell Rural Sanitary District (Cornwall); population, 26,354; Dr. Parsons.

Sanitary Authority: St. Austell R.

Ground of Inquiry: Diphtheria.—Registrar General's Returns.

Chief Facts reported: Outbreaks of diphtheria in August and September in the parishes of Roche and St. Stephens. Diphtheria was accompanied by a prevalence of sore-throat not diphtheritic in appearance, but probably of same nature. The disease propagated chiefly by personal intercommunication, at day schools and elsewhere. *See* p. 83 of present volume.*

30. St. Joseph's Certified Industrial School for Roman Catholic Girls (Manchester); inmates, 172; Dr. Page.

Sanitary Authorities: Manchester and York Corporations, U.

Ground of Inquiry: Outbreak of small-pox.

Chief Facts reported: Of 172 inmates, including Sisters and attendants, 51 attacked with small-pox of widely varying degrees of severity; three deaths among the 10 unvaccinated inmates. Infection introduced by a pupil admitted on July 6, who sickened immediately on arrival at the institution. Institution at that time without medical supervision; and the nature of girl's illness escaped recognition until occurrence of a general outbreak of small-pox amongst the inmates on July 27. *See* p. 52 of present volume.†

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* Report reprinted as App. A. No. 9 of present volume.
† Report reprinted as App. A. No. 6 of present volume.

31. Spennymoor (Durham); population (1881), 5,917; Dr. Page.

Sanitary Authorities: Spennymoor Local Board, U., Durham R., and Auckland R.

Ground of Inquiry: Prevalence of scarlatina and enteric fever.—Report of Medical Officer of Health.

Chief Facts reported: Fatal prevalence of scarlatina in 1879, and 1881; prevalent again, but with small mortality, in 1884, since which time the disease has been more or less continuous in the district. Recent outbreak due to spread of infection in ordinary fashion,—by personal intercourse, by school attendance, and by habits of people and the conditions of colliery dwellings.

Enteric fever a source of mortality annually. Recent outbreak associated with general and local defects of drainage, and especially of excrement disposal, but associated also in time with prevalence of fever at a farmhouse whence milk was distributed in Spennymoor to a considerable number of the persons attacked.

District inspected by Dr. Thorne Thorne in 1874; again inspected in 1884 by Dr. Parsons on account of fever prevalence, and a third time by Dr. Page in 1885 in connexion with Cholera Survey. Improvement much needed, especially as to the midden privy system, which is still in general use and a cause of grave nuisances and danger to locality. Want of sewer and house-drain ventilation. Water supply good. Byelaws in need of enforcement, especially as to pig-keeping near houses. Absence of hospital accommodation and of means of disinfection.

32. Standish-with-Langtree (Lancashire); population (1881), 4,261; Dr. Page.

Sanitary Authority: Standish-with-Langtree Local Board, U.

Ground of Inquiry: Prevalence of enteric fever. Conference with recently appointed Medical Officer of Health.

Chief Facts reported: New Medical Officer of Health in need of guidance upon several important matters involving action of the Authority;—notably the practice of draining privy middens into the sewers, and of scavenging these privies during night and without due precautions to prevent nuisance.

Ventilation of sewers at manhole gratings purposely obstructed with a view to repress foul emanations therefrom. Midden privies drained into sewers, causing nuisance. No flushing of sewers.

Water supply from local sources, one of them exposed to excremental pollution; incidence of fever chiefly in families using this supply, but spread of the disease also attributable to privy defects. No system of scavenging. Prevalence of nuisances from unpaved, undrained yards, and from pig-keeping. Nothing of note done since Dr. Parsons's inspection in 1884. General neglect of sanitary administration.

33. Stourbridge Rural Sanitary District (Staffordshire Division); population, 20,791; Dr. Parsons.

Sanitary Authority: Stourbridge R.

Ground of Inquiry: Enteric fever.—Reports of Medical Officer of Health.

Chief Facts reported: A severe outbreak of enteric fever in third quarter of 1888, in a limited area in the townships of Pensnett and Bromley. Special incidence on young adult males employed at ironworks and in other occupations involving exposure to heat. Beverage commonly in use by such persons, ginger beer, made often at home, from the water of polluted wells, not wholly boiled.

No sewerage; slop-water nuisances prevalent. Privies with wet open ashpits. Pig-keeping nuisances. Wells exposed to pollution from these sources. South Staffordshire Waterworks Company's water at hand, but Authority do not enforce its use.

34. Stourbridge Rural Sanitary District (Worcestershire Division); *Halesowen*, population, 3,338; *Cradley*, population, 5,283; *The Lye*, population, 6,323; *Wollescote*, 3,059; Dr. Parsons.

Sanitary Authority: Stourbridge R.

Ground of Inquiry: To ascertain action taken by Authority to carry out Board's Order of January 25th, 1886, under section 42, Public Health Act, 1875.

Chief Facts reported: Contracts entered into by the Rural Sanitary Authority, in obedience to the Order, for the removal of refuse and for the cleansing of privies and ashpits in the townships specifically mentioned in Order, and in one other township.

Very large accumulations of refuse matters not numerous at date of infection. A few ashpits furnished with covers; but little or nothing done towards securing an improved system of privy construction; privies as at previous inspections too few in number, too near in some cases to dwelling-houses, often dilapidated and in a filthy condition, and frequently, as of old, connected with large, deep, wet, leaky ashpits. Neglect of surface cleanliness. Want of sewerage (especially at The Lye) aggravated by introduction of more copious water supply. Urban powers needed. Negligent sanitary administration; work of Medical Officer of Health perfunctorily performed.

35. Walthamstow (Essex); population (estimated), 41,760; Dr. Airy.

Sanitary Authority: Walthamstow Local Board, U.

Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

Chief Facts reported: Increase in recent years of prevalence of diphtheria throughout West Ham Registration District. Severe outbreak in Walthamstow in 1887–88, spreading chiefly among children attending certain schools, and specially affecting one particular street. Drains ill-trapped. Water from East London Waterworks. No isolation hospital.

App. A. No. 7. Abstract of Medical Inspections.

36. Whitford Registration Sub-District (Flintshire); population, 8,437; Dr. Parsons.

Sanitary Authority: Holywell R.

Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

Chief Facts reported: Diphtheria occurred in five households in the parishes of Llanasa and Whitford; 19 cases and 5 deaths. Four of the invaded houses old cottages, ill-ventilated and more or less crowded, and with uncleanly surroundings. Water and milk of invaded families obtained from different sources, and no connexion established between the outbreaks in the several households. Infection perhaps conveyed by unrecognised cases, sore-throats having been especially prevalent during the past winter. One invaded house, a large hall, the family occupying which had repeatedly suffered from ulcerated sore-throats; grave defects of drainage found here.

37. Workington (Cumberland); population (estimated), 24,000; Dr. Page.

Sanitary Authority: Workington U.

Ground of Inquiry: Diphtheria.—Registrar-General's Returns.

Chief facts reported: During 1887, 15 deaths registered as due to "Croup"; other 17 as due to diphtheria. Of the 32, 27 deaths were in children 5 years of age and under. These deaths were scattered over the borough, but perhaps were specially numerous in a low-lying district of new-made and undrained private streets. No information available as to antecedent or concomitant throat affections that were not fatal. The deaths occurred singly in separate households, medical and other evidence being to the effect that persons fatally attacked were the only sufferers in their families, though no pains to isolate them or special precautions against infection had been taken. No evidence of means of introduction or spread of infection; schools seemingly not implicated. Office of Medical Officer of Health vacant since July 1887. Duties of Surveyor performed by Inspector of Nuisances.

No. 8.

Report on Diphtheria in Ashbourne Urban Sanitary District; by Dr. Bruce Low.

This inquiry was ordered in reference to serious mortality from diphtheria in the Mayfield and Ashbourne Registration Sub-districts, recorded in the quarterly returns of the Registrar-General. At first sight the urban and rural sanitary districts of Ashbourne had both to be regarded as affected by this outbreak of diphtheria. But on visiting the locality it was found that of 22 deaths from diphtheria which were in question, no less than 18 had occurred in Ashbourne town; and that so far as the disease had affected the rural district, much, if not all of it, had been related to previous cases of diphtheria in urban Ashbourne. Accordingly, in what is here reported concerning this prevalence of diphtheria, the town of Ashbourne alone will be dealt with.

The Ashbourne Urban Sanitary District, with an area of 523 acres and a population (at the Census of 1881) of 3,845, is situated in a deep valley in the southern part of Derbyshire. Ashbourne has a weekly market and several annual fairs. There is consequently considerable communication between the town and the surrounding district.

A stream, the Henmore, divides the town into two parts, Ashbourne and Compton. The Ashbourne portion to the north of the stream, and mainly on sharply rising ground formed of new red sandstone, consists for the most part of one long principal street (Church Street), at the upper end of which is the market place.

Hereabouts, and especially east of the market place, dwellings are crowded together in back yards or courts, entered by narrow passages. Compton, on the other hand, is low-lying on gravel and alluvium, and in rainy seasons is liable to be flooded by the stream. It is connected with Ashbourne by a bridge, and its main street runs almost due south. A large proportion of the population here inhabit crowded backyards or courts behind the main street. The dwellings in these courts are commonly old, damp, and in many cases overcrowded. As a rule they have only doors and windows on one side, and, as in the houses behind the market place, there is an absence of free movement of fresh air in and around them. The yards are mostly unpaved and irregular, so that the surface is often fouled by stagnant sewage.

The industries of Ashbourne are those usual in a small country town; in addition, there is a stay factory in Compton, employing, it is stated, about 300 hands. And outside the town, about a mile-and-a-half lower down the valley (at Mayfield), there is a cotton factory employing 500

hands, many of whom are residents at Ashbourne. Of the total population of the urban sanitary district, two-thirds reside on the north side of the Henmore Brook, but in Compton the artisan class is more strongly represented than in Ashbourne. Owing to its position near Dovedale and other places frequented by tourists, there is in summer time a constant stream of visitors through Ashbourne, and the hotels and other houses are consequently well filled during the season. Its horse fairs, too, bring persons from all parts of the country, and its pleasure fairs are well attended by the rural population round about. On the occasion of these fairs, nomadic show people, gipsies, and other wandering folk flock to the town. Some of these people are permitted to set up their carts and caravans in the market place, littering the surface with their filth, and washing their soiled rags at and around the public pump.

Diphtheria.

Diphtheria has from time to time appeared in the town of Ashbourne, but it has never before been known in such amount as in the outbreak here under consideration. As elsewhere, it has been principally a disease of the rural district. So far as can be gathered from previous reports, the last recorded death in the urban district took place in 1883, *i.e.*, five years ago. But in 1884 several non-fatal cases were observed there, two of which occurred in White Horse Yard; the locality in which, so far at least as can be discovered, the diphtheria of the present outbreak first made its appearance. Up to the third week in October 1887 no diphtheria had been heard of since 1884. From the middle of October to the end of December 1887, nine deaths in the town were referred to this cause. Of these, six occurred in persons who resided in or close to the market place, and two in persons who lived a little way off, and who had attended daily a school just behind the market place; the father of the ninth case (an infant aged eight months) kept a butcher's stall on certain days of the week in the market place. In 1888, from January 1st to May 10th (when the last death from diphtheria was recorded), nine additional persons were registered as dying from this cause. But of these only three lived near the market place, the other six having resided in and about Compton. As to the number of non-fatal attacks by diphtheria that occurred in this outbreak, nothing could with certainty be learned; but as in other outbreaks of diphtheria elsewhere, so in the present instance there was throughout the whole of the eight months a widespread and general prevalence of sorethroat, for which medical advice was rarely sought. It was therefore only the severe and generally fatal cases which came under the observation of the local medical men. For a while, indeed, the very nature of the malady was for some reason regarded as open to question, and thus it happened that of the nine deaths from October to December 1887, six were certified as "croup," two as "diphtheritic croup," one as "croupous diphtheria." But of the nine deaths which took place in 1888 (January to May) two were certified as "diphtheritic croup," one as "croupous diphtheria," five as "diphtheria," and one as "capillary bronchitis."*

* The medical man who certified this death only saw the child a few hours before its death, when it was moribund; but as another child—a sister—died afterwards from diphtheria in the same house, and as the parents and the grandmother unite in asserting that the symptoms were identical in both cases, the medical man now considers that the first child also died of diphtheria.

With difficulties of this and other kinds to contend with, it was found impossible to obtain anything like a trustworthy account of the cases of a diphtheritic nature which had occurred in the place; and therefore the following table of cases (which has been compiled under somewhat unfavourable circumstances, and at a considerable expenditure of time and trouble) is to be taken as indicating the time-incidence of the diphtheria cases rather than the amount of the malady which had prevailed in Ashbourne.

TABLE

Showing NUMBER OF HOUSES invaded in each month, October 1887 to May 1888, by Diphtheria or allied throat affection, TOTAL CASES, and DEATHS in Ashbourne Urban Sanitary District.

Month.	Houses invaded.	Total Cases.	Ultimately Fatal.
October	3	7	2
November	9	23	5
December	2	4	2
January	4	8	4
February	4	8	2
March	3	5	2
April	1	1	1
May	—	—	—*
Totals	26	56	18

* A death occurred in May in a house invaded by fatal diphtheria in February; the death is therefore referred to the latter month, *i.e.*, the time in which the house became infected.

From the Table it will be seen that, from the middle of October 1887 to the beginning of May 1888, record was obtained of 26 houses invaded by diphtheritic disease; 56 persons suffered, and of these 18 died. Of the 18 deaths 16 occurred in children aged five and under; of the two over five years of age, one being six and the other eight.

Having regard to the interval of time between the commencement of this outbreak of diphtheria and the present inquiry; having regard also to the fact that the nature of the malady went for a long while unrecognised; and further having regard to the uncertainty thus arising, not only as to the total amount of diphtheria and the localities of its incidence, but as to whether the earlier deaths in October from throat illness were really to be looked upon as marking the beginning of the outbreak, it appeared altogether unlikely that any sufficient explanation of the origin of this diphtheria would be forthcoming. Nevertheless, in the course of the collection of the data above named, certain facts came to light, which

seemed to call for careful consideration in regard to their bearing on the spread of the disease. These are as follows:—Of the 14 families known to have suffered from diphtheria between the middle of October and January, no less than nine were invaded in the persons of children attending the National Infants' School; in other three families, the first sufferers had been habitually in direct relation with children attending that school; only two out of the 14 families (invaded in November and December) had no apparent connexion with this school. These facts were altogether consistent with the infant school having been a prime agent in setting diphtheria a-going in the place. It is becoming common knowledge, indeed, that, at the autumn season, schools (especially infant schools, as containing children at ages most susceptible to diphtheria) are apt to afford facilities for a minor form of illness, essentially diphtheritic in its nature, to rapidly extend itself among children, with a concurrent development and intensification of the grave phenomena of unmistakable diphtheria. And, in corroboration of the view, that the Ashbourne Infant National School had acted such a part, was the circumstance that, as regarded the majority of the earliest (known) sufferers by the outbreak, there could not be found any common condition of a kind likely to have been causative of diphtheria, except this fact of their attendance at, or intimate relation with the infant school in question. Accordingly, attention was directed tothis school. It is dissociated from the other national schools (the boys' and the girls'), and is situated in a somewhat crowded locality close behind the market place. At first there did appear to be some conditions peculiar to the school which might perhaps have been thought to be concerned in the fostering of the diphtheria; but this view was very soon met by a statistical consideration entirely in opposition to a hypothesis of the school being the chief agency in the causation of the outbreak, namely, that though the school received town infants from both sides of the river (in a particular week just before the outbreak 73 attended from Ashbourne and 42 from Compton), the diphtheria had been limited to such of them as reside d north of the river in Ashbourne proper. Accepting this induction as provisionally a fact, it was next sought to ascertain whether there was to be found any condition common to the Ashbourne infants attacked, but not shared by their companions in Ashbourne and Compton who had apparently escaped the illness. *Primâ facie* there appeared the circumstance that the sufferers had, for the most part, resided at or near the market place, and, as a result of this, the inquiry became involved in a host of complex considerations. Among others there were these: the earliest known case occurred in a house where there had been diphtheria four years previous to this; there was general prevalence of dirt, and overcrowding of dwellings, foul privies, emptied or not emptied, pig-keeping, emanations from slaughter-houses (establishments specially abundant in the neighbourhood of the market place), slaughter-house blood in the sewers, congregation of human beings and animals, along with a haunting, by strangers to the town, of public-houses in the market place, and the promiscuous using by all comers of the backyard open privies attached to these houses; all of which considerations, under the conditions of an inquiry nine months later than the events it was concerned with, constituted a problem the solution of which was quite hopeless. Meanwhile there was the not remote possibility that the apparent escape up to January of the Compton children attending the infant school had been an escape only in so far as grave or fatal diphtheria was concerned; indeed, it was not possible to throw off the suspicion that the Compton infants had,

despite the suggestion to the contrary, borne some share of the malady that was rife in Ashbourne before Christmas 1887. As to the outcome of the inquiries into the connexion of the disease specially with the market place, it is only necessary to draw attention to the slaughter-houses and their sewer connexions as perhaps deserving of attention in future investigations as to the apparent origin of special diphtheria outbreaks.

In the course of the inquiry, which extended over several days, abundant opportunity was afforded for observing the sanitary state of the place. A brief account is here given of the chief facts noted in this connexion.

The water supply is entirely from wells. Those on the north side of the stream, and especially those in the higher part of the town, are comparatively deep, but those nearer the stream are shallow. In Compton, they are mere surface wells about 15 feet deep. There are three public wells in Ashbourne proper, kept in order by the urban sanitary authority, (1) in Dove House Green, said to be 96 feet deep, (2) in the market place, about 54 feet deep, and (3) in Church Street, opposite the Wesleyan Chapel, only 18 feet deep. In the summer and autumn of 1887 the well in the market place became almost dry, and it was found necessary to lock up the pump from time to time to allow the water to accumulate. Complaints were made by the people round about regarding this scarcity, and many had to beg water from those who had private wells. At this time, also, the public well in Church Street went nearly dry, and the water pumped from it became dark and muddy. No complete quantitative analysis of the water of these public wells has been made of late years, but the Medical Officer of Health states that, although the supply generally is hard, yet it has not been found contaminated, at least when tried by the usual qualitative tests. Most private houses have wells of their own. Those houses which have none get their supply from one or other of the three public pumps, or beg from their more fortunate neighbours. The shallower private wells, and and especially those in Compton, are very liable to pollution. In one instance observed, the urinal attached to a public-house was within two yards of the pump; the urine could be seen on the surface, soaking through the unpaved and unprotected yard above the shallow well. In other cases pigstyes, dung heaps, and other collections of animal matter, were seen in close proximity to wells. The nature of the subsoil is favourable to soakage. As the lower part of Ashbourne and most of Compton are liable to become flooded when the stream rises, another facility is provided for fouling the wells. Owing to the scarcity of water last summer and autumn, many of the yards could not be thoroughly "swilled" out, and surface pollution was therefore common. From this short account of the water supply it will be seen that it is neither sufficient in quantity nor, as regards Compton and the lower parts of Ashbourne, safe in regard to its quality.

The drainage of Ashbourne discharges without any treatment into the River Henmore below the railway station. The sewage is carried by the current down the stream, and deposited chiefly in the mill dam at Clifton, about two miles below Ashbourne. The solid matter subsides here, the clear water running off. Great complaint is made by the residents at Clifton regarding the nuisance thus created by the

Ashbourne sewage.* The steeper parts of Ashbourne are provided with pipe sewers having a fall of 1 ft. in 10. In the market place the fall is one in 13; the main sewer is carried by a brick culvert below the bed of the Henmore, and is joined lower down by the sewers of Compton; after this the sewage discharges by a common outfall into the brook below the railway station. The fall of the brick culvert after passing beneath the Henmore is one in 270; there are two other short sections, both at the east end of the town, one being on either side of the stream. They discharge by independent outfalls into the brook, but lower down. Compton was drained before the formation of the Ashbourne local board. There are only a few ventilating openings in the roadway for the whole system, not more than 10 such gratings in all; these are quite insufficient for the purpose. There are also four manholes. There is no systematic flushing. Occasionally, in dry weather, a water cart is filled and taken to the top of the town and discharged into the drains through one of the openings in the roadway. But owing to the scarcity of water at such seasons, this is not often done. Complaints of smells from the ventilators have been made, especially under certain atmospheric conditions. There is nominally a separate system of drains for carrying off the rain water from the streets, but there is reason to suspect that the two systems communicate with each other, as smells can often be perceived at the storm-water gratings. The sink stones in some houses communicate directly with the drains.

Excrement disposal.—Some of the better class houses have waterclosets, the water for which is either pumped up from the wells in the yard, or, as in some of the more modern houses, rain water is collected and stored for this purpose. Many of the poorer houses have, in the back yards, waterclosets, which have to be handflushed. In several cases these were found in a filthy state, crammed with excrement, and completely stopped. The scarcity of water, and the necessity of carrying it from the well or public pump to the closet, are not favourable towards keeping such closets clean. In the older parts of Ashbourne there are a number of vault privies, emptied at long intervals. In one instance the vault (which was overflowing with liquid filth) had not been emptied since the tenant came to the house, five years ago. In another case the vault had not been touched for four years. Vault privies are used at the three national schools, and are said to be emptied only once in 18 months. At the Infants' National School, it is necessary to break up the asphalted surface of the small yard used as a playground to reach the vault when it is to be emptied. There are some ash-privies in the town; cesspools still exist in the gardens of some of the older and better class houses; these and the vault privies are a source of considerable danger to the wells which are so closely adjacent.

House refuse removal.—This is done by the local board. The staff for this purpose consists of three men with two carts. Every Thursday the carts go round and collect the ashes and other refuse, which have

* In the course of the inspection several large milk cans were seen at one point, a mile below the town, and in the rural sanitary district of Ashbourne, cooling in the current of this sewage-laden stream, preparatory to being sent off by the night train to London. It is easy enough to see that specific contamination might be in the stream, and that, by splashing or by other means, the specific contagion contained in the water might with ease reach the milk. The well of the dairy farm to which the cans belonged is situated only about 20 ft. from the channel of the brook.

been previously brought out in boxes or barrels to the kerbstone. This refuse is led away to a piece of land outside the town.

Pig-keeping.—In some cases pigs are kept in close proximity to dwelling-houses. The Medical Officer of Health states that this nuisance has been considerably lessened during the last two years, but something yet remains to be done. In one case 16 pigs of various sizes were seen within 30 feet of two cottages in a close court. In some of the Compton yards pig-tubs create a nuisance.

Slaughter-houses.—There are eight of these in Ashbourne. Several of them are situated behind the market place in crowded and unsuitable positions. From the windows of the infants' national school three can be seen; one of these is only 14 yards distant; the second nearly as close, while the third is about 60 yards away. These slaughter-houses are registered or licensed, and are under the byelaws of the local board. At the date of inspection they were found fairly clean, and the byelaws appeared to be observed. The day for slaughtering is usually Thursday, and it is said that on that day the main outfall of the drainage discharges into the Henmore a large amount of blood-coloured sewage. It would be preferable if a public slaughter-house were provided outside the town, and under the immediate and constant supervision of the urban authority.

Sanitary administration.—The local board was formed in 1867, and consists of 15 members. General byelaws were approved by the Home Office on 29th April 1868. In March 1882 byelaws for streets and buildings were approved by the Local Government Board. Loans were sanctioned as follows:—

	£
9th May 1868, for drainage - - -	1,000
19th December 1874, for drainage - -	500
5th June 1882, purchase of cattle market -	3,000
Total loans - -	£4,500

The general district rate averages 2*s.* 6*d.* in the pound.

The Medical Officer of Health receives 10*l.* per annum, half of which is repaid by the Board. His recommendations are not acted upon by the local authority; and so perhaps it has come about that this officer devotes less time than necessary to his duties. Moreover, it is hardly to be expected that a medical officer of health will, for such a remuneration as that just named, devote to his authority any considerable portion of that time which would otherwise be occupied by his private practice. The sum allotted to him as medical officer of health may fairly be regarded as measuring the amount of service expected from him.

The Inspector of Nuisances receives as such 50*l.* per annum. He is also employed as surveyor, market inspector, and collector to the local board, for which he receives another 50*l.* per annum. The pressure of his duties as collector, &c., prevent him carrying out systematic inspections, which are so necessary for any district. In 1887, 36 notices to abate nuisances were issued, and of these 35 were abated and one is still under consideration.

Hospital provision.—There is none for the treatment and isolation of acute infectious diseases, unless one should reckon the venereal wards at the workhouse. For patients, pauper or other, suffering from contagious fevers, there is no public provision whatever. On a recent occasion this want was seriously felt, four cases of small-pox (two fatal) having to be treated under circumstances of great difficulty at the workhouse. There is no disinfecting apparatus, nor any system for notification of sickness to the sanitary authority.

No. 9.

REPORT on a recent PREVALENCE of DIPHTHERIA in the PARISHES of ROCHE and ST. STEPHENS, in the ST. AUSTELL RURAL SANITARY DISTRICT, CORNWALL; by DR. PARSONS.

THE return of the Registrar-General for the third quarter of 1887 showed that four deaths from diphtheria had been registered during the quarter in the St. Austell sub-district of the St. Austell registration district, a note by the registrar stating that these deaths had occurred in the parish of Roche. Another death from the same disease was registered in the Grampound sub-district. Diphtheria.

Correspondence with the Rural Sanitary Authority having failed to make clear the causes of the outbreak, a local inspection was ordered, and was made by me in January 1888. I found that, with the exception of a single fatal case at Tywardreath, which there was reason to believe had been imported, the recent prevalence of diphtheria had been limited, so far as could be ascertained, to the two parishes of Roche and St. Stephens. In the former of these parishes there had been four more deaths from diphtheria in the last quarter of 1887, making, with one in the second quarter, a total of nine deaths out of about 30 recognised cases, occurring in 19 households. In the latter parish about 21 cases were heard of, occurring in eight households, with only two deaths. The two parishes adjoin one another, but the parts where the persons who suffered from diphtheria resided are about three miles apart, and there appears to be but little intercourse between the two places. As the outbreaks in the two parishes appear to have been distinct, though running a similar course, I shall treat of them separately. At Roche and St. Stephens.

Roche (population of parish, 1,681) is an extensive parish, on high ground, on the north slope of a range of granite hills attaining 1,000 feet in height. Much of the surface is rough and uncultivated, and has been at one time or another disturbed by workings for china clay and other minerals. To the north is a wide tract of peat. The inhabitants, who are mostly employed in the clay works and in agriculture, reside partly in the church town or principal village, partly in outlying cottages and farms scattered singly or in groups of two or three over the remainder of the parish. Roche.

The origin of the outbreak is uncertain. The earliest known cases of diphtheria in Roche in 1887 occurred at an outlying farmhouse called Retillick, about a mile S.W. of Roche village, where two little girls, aged 13 and 8, were taken ill on or about May 8th. The younger, who attended the infant school at Roche, had been ailing a day or two before this with what was thought to be a cold. The only history of exposure to infection ascertainable was that there might possibly have been communication on Sundays with members of a household (R.) a mile off, in which there were at that time cases of scarlet fever with marked throat affection. Mr. Mason, Medical Officer of Health, who saw these cases (R.) at the time, says that they were undoubtedly scarlet fever; one of them died on May 20th, the certified cause of death being "scarlatina anginosa." (It is to be noted that the name "throat fever" is locally given both to diphtheria and to scarlet fever with prominent throat symptoms.) The farmhouse at Retillick, like many others in the district, has adjoining it a dirty cattle yard, containing much manure, and into which the refuse of the household is thrown. Water is obtained from a pump well close to the house, and therefore near the yard. First known cases.

The subsequent progress of the disease, as shown by the number of households newly invaded in each month, has been as follows: May, 2; Subsequent progress.

June, 0; July, 1; August (end), 3; September, 4; October, 3; November, 3; December, 2; January 1888, 1; total, 19. One case was still under treatment at the time of my visit.

Propagated by contagion.

As regards the means by which the disease was spread, I am of opinion that, in most instances, its occurrence may be accounted for by infection contracted from a previous case; more especially if we may allow that the known cases of diphtheria were accompanied by a number of mild unrecognised ones. I learnt from more than one source that sore throats were very prevalent in Roche last autumn. Thus the schoolmaster at the Roche Board School states that at the time when diphtheria was prevalent, and to a less degree before and afterwards, many of the school children had sore throats, and used to come to school with their necks tied up in flannel. Experience gained elsewhere has shown that outbreaks of diphtheria are frequently accompanied by a similar prevalence of sore throats not distinctly diphtheritic in character, and has shown it to be probable that though such cases may not, from a clinical point of view, come within the definition of diphtheria, they are essentially of the same nature, and that a susceptible person coming in contact with one of them may contract the disease from it in a severe form. We must also admit that the susceptibility to diphtheria varies greatly in different persons. Thus, in one family in Roche, not worse housed than their neighbours, three out of four of the younger inmates contracted diphtheria, and two died; while in other instances a single case only occurred in a crowded family of children. The persons who contracted diphtheria had opportunities of coming in contact with infection in various ways, *e.g.*, by ordinary social intercourse, by attendance at schools (both at the Board school and Sunday schools), at places of worship, in service, &c.

In one instance three young girls of different families went out for a walk together one Sunday. One of them had just recovered from diphtheria, and her throat was still sore. The two other girls were both taken ill of diphtheria in the course of the week, one on Tuesday, the other on Thursday.

Partially at Board school.

In several cases occurring about the same time in September and October, the patient (being the first case in the family) was a child attending the Board school at Roche. (One of these children resided at a very isolated house in the adjoining parish of Luxulyan, in the Bodmin Union.) These cases had given rise to suspicion against the Board school as having to do with the spread of the disease; rather, however, through the alleged unsanitary condition of the school closets, than as propagating contagion. I find, on examining the school registers, that in several instances at the time when children were at home ill of diphtheria, other children of the same family continued to attend school. It would appear that at Roche considerable pressure is brought to bear upon people to send their children to school, and that the existence of sickness, even of an infectious nature, is not readily admitted as an excuse for non-attendance. Owing to the approaching examination (held October 20th and 21st), the School Board were at first unwilling to close the school, but it was closed from November 1st to 28th, as the Medical Officer of Health thinks, with good effect. As, however, in more than half of the households attacked by diphtheria at Roche, the first case was not a child attending school, unwholesome influences existing at the school cannot have been the sole or chief cause of the outbreak.

The school privies are of the cesspit kind, discharging into a large covered vault at the back. The schoolmaster's closet has a pan, connected

with the same vault by a short pipe drain, through which the contents are supposed to be flushed by pouring down water by hand. Owing to the scarcity of water last year, the closet pipe, being insufficiently flushed, had got blocked up. The school closets too, though clean at my visit, are described as having been then in a filthy condition. The closets have since been cleaned, and the cesspit emptied, and a narrow pipe erected with a view to ventilate it. It is said that no liquid was found in the cesspit when opened, and as the well from which the water supply of the school and master's house is obtained is only about 30 feet distant, there appears to be reason to fear that percolation may take place from one to the other.

Of the houses invaded by diphtheria in Roche, 10 were in the village, and nine in outlying places.

Sewers.

The village of Roche is partly drained by a sewer, described as of 9-inch pipes with cement joints, discharging into a brook. The outfall has recently been furnished with a trapping bend, to prevent the wind blowing up the sewer and forcing out foul air through the gratings above; but no means of ventilation have been provided for the escape of such gases as may be generated in the sewer. There are no means of flushing the sewer.

Drains.

The course and construction of the house-drains appear to be imperfectly known; the newer ones are of socket pipes, but some of the older ones are square and of stone; some run under houses. The inlets are out of doors, but are trapped only with a defective form of iron trap, frequently stopped up, or broken loose, so as to allow the issue of foul air.

Another part of the village is drained into an open ditch, fairly clean at the time of my visit, but described as offensive in summer. This discharges by an irregular course into an open sewage pool near the village, and thence into the brook before mentioned. The outlying houses have no drains, or only short channels conveying waste water into the nearest watercourse, or over a field.

Privies.

In Roche village some of the houses have hopper-closets, connected with the sewer, and flushed by pouring down water by hand; others have pail closets of which the contents are utilised on the gardens; others again have privies of the old kind, but usually a good way from the houses. On the whole the village is very fairly free from excremental nuisances.

Water supply.

The water supply of Roche village is derived from a public well, and from a number of private wells, mostly of some considerable depth. The public well is within a few feet of the sewer, but some steps have recently been taken to prevent the percolation of sewage into the well. Of the private wells, some which are near sources of contamination are admittedly unfit for drinking, and some failed during the past dry summer. The water supply of Roche village is therefore not altogether satisfactory either in quantity or quality, and the Medical Officer of Health has recommended that a better supply should be provided. There is a spring from which water might be brought down to the village, but the Sanitary Authority have not seen their way to do so, partly on the ground of expense and the opposition of the local rate-payers, partly on account of the difficulty which it is said there would be in getting permission to use the water, water rights being very valuable in this district on account of the great demand for water at the china-clay works. The outlying houses get water from springs or streams.

Dwellings.

Some of the houses in which diphtheria occurred were old, dilapidated, and damp; but others were new and in good condition. The surroundings of some, especially in outlying places, were in a filthy state through want of proper paving, and accumulations of manure.

Other conditions.

Although I have mentioned unsanitary conditions as existing at Roche, it is not clear what influence, if any, these had upon the occurrence or severity of the diphtheria. The fact that the households attacked were nearly equally divided between the village and the outlying houses shows that neither defects of the village sewer nor absence of sewerage could have had much to do with it. The water supply for the households attacked came from a number of different sources. The same may be said of the milk supply, which indeed came in many instances from the parties' own cows.

Inquiries were made as to prevalent diseases of lower animals, both of cattle, and also of cats and fowls, which are believed to be subject to diphtheria; but none were heard of.

As regards atmospheric conditions, it is to be observed that the time at which the diphtheria, which had been smouldering for some months, started into increased activity, was that at which the hot dry summer of 1887 was suddenly succeeded by a cold stormy autumn.

St. Stephens.

St. Stephens.—In this extensive and populous parish the recent diphtheria has been limited, as far as my information goes, to the localities of Nanpean, Old Pound, and Currian. Nanpean is a village of some size, with houses in a street, a church, and Board school; the other places are each about a mile distant from Nanpean, and consist of a few widely-scattered cottages.

Diphtheria at Old Pound.

The earliest known case of diphtheria in this neighbourhood in 1887 was a young man at Old Pound, Richard S———, age 19, who was ill about March. The origin of his illness was not ascertained. He worked at clay works in the neighbourhood, and had not been away from home. Two years ago he and the whole family, with the exception of the father, suffered from "throat fever," but this was no doubt scarlet fever. It was accompanied by a red rash, and one of the patients suffered afterwards from rheumatic fever and dropsy. It was introduced by a daughter who came home ill from service in a house where a fatal case of scarlet fever had occurred.

No other cases of diphtheria occurred in the S——— family in 1887, although the cottage in which they live is overcrowded, there being only two bedrooms for a family consisting of father, mother, and seven children, including adolescent sons and daughters. The cottage itself is in fairly good condition, but there is a defective stone drain, choked with sediment at the time of my visit, close to the wall outside.

Three cases of diphtheria, one fatal, occurred in May at another cottage at Old Pound. In the fatal case the disease is said to have followed whooping cough. There might have been communication with the previous household, as members of both attend the same chapel and Sunday school. The cottage was found in a dirty and neglected state, and is approached through an exceedingly filthy yard.

A Nanpean and Currian.

In September 1887 diphtheria broke out in five households in Nanpean and Currian; the first case in each being a child attending the Board school at Nanpean, and most of them being in the same class. Four out of the five children were cousins and used to meet elsewhere than at the Board school. The schoolmaster informs me that about that time a number of children at the school had sore throats; indeed two of his own children suffered, and one had to keep his bed for two days. The medical man who saw the schoolmaster's children tells me that they suffered from ordinary inflamed sore throats, not diphtheria. Of the probable relation between such epidemic prevalence of sore throats of an apparently non-specific nature, and diphtheria, I have spoken in reference to the outbreak at Roche. At the time of my

visit, I saw at Currian in one household a girl with decided diphtheria, and a sister suffering from quinsy, a single tonsil being much swollen and inflamed, but without any diphtheritic exudation. In another family at Currian I found three children, all suffering from sore throat, but without any of the characteristic appearances of diphtheria.

Sanitary condition of houses.

As regards sanitary condition, the state of some of the outlying houses and their surroundings was filthy in the extreme. At those referred to, cattle and pigs are kept, and there is no paved path to the house, the only approach being through a yard, deep in manure and semi-liquid filth which everyone who enters the house must bring in on his boots. In such cases the keeping of the house clean is a hopeless task, and the housewife had evidently given it up in despair. Many of the outlying houses are without privy accommodation, and some were overcrowded. Nanpean village is unsewered; there are only a few short drains, roughly built of stone, which convey slop-water into the "water-table" or gutter at the side of the road. At a house at which diphtheria existed, I saw the washing water poured on the waste ground in front of the house, and standing in the gutter by the side of the public road.

No sewers.

Water supply.

Nanpean has a public supply of water from stand-posts, but this supply is liable to be fouled by clay washings, and is not used for drinking. For drinking purposes water is fetched from a spout in a clay pit, and has to be carried up a steep path. The water comes from an old mine adit, and is brought to the spout by a stone drain. This conduit runs under a rough hollow, into which household refuse is thrown, and I saw human excrement lying just over its course, close to the spout. The water supply at Currian is partly obtained from a spring, liable to fouling by cattle; but the different households attacked by diphtheria obtained water from several different sources, so that I cannot ascribe the origin of the disease to the use of water from any particular source.

Inquiries as to milk supply, and as to diseases among domestic animals were made with results as at Roche. I believe that the most probable explanation of the chief outbreak in both parishes is that the disease had been present for some months previously, partly in an unrecognised form; that the disease germ, whatever it may be, assumed, through seasonal or other changes, a greater activity; and that it was spread mainly by personal intercommunication at school and elsewhere.

I was unable to find any link between the outbreaks at Roche and St. Stephens, although they ran a parallel course. The first known case at Old Pound occurred about two months before that at Retillick. No communication between the two places could be elicited. Old Pound is 2½ miles due south of Retillick, and on considerably higher ground.

Preventive action.

Nearly all of the houses in which diphtheria was known to have occurred had been visited by the Medical Officer of Health, Mr. Mason, of St. Austell, from whom I received valuable assistance, which I desire to acknowledge.

Little had been attempted in the way of isolation of the sick, owing to the absence of facilities at the patients' homes, and of any hospital which might be used for the purpose. It appeared to me that more action might with advantage have been taken in the way of excluding from school the children of affected families, and those with sore throats, which, when diphtheria is prevalent, are always to be looked upon as suspicious. The Board's official memorandum on this subject might with advantage be consulted by school managers as well as by the Sanitary Authority and their officers.

Nuisance-inspection of district insufficient.

Disinfectants, with printed directions for their use, have been supplied gratuitously, and in some cases the cleansing and limewashing of infected rooms has been seen to. In some instances sanitary defects had been discovered, and action taken for their removal. A much closer supervision of the district is, however, required for the detection and removal of nuisances, more especially at the outlying houses. In so saying I do not lay blame to the Inspector of Nuisances personally, but to the terms of his appointment. The salary of the Inspector of Nuisances has been cut down from time to time, until the present holder of the office, Mr. Thorpe, receives but 80*l.* a year for the supervision of a district of 58,080 acres, with a population of 26,604. The district is ill provided with public means of conveyance, and, as the Inspector's salary is not sufficient to enable him to keep a horse, most of his journeys have to be made on foot. Much of his time also is occupied in the preparation of plans. The principal villages seem to be visited, but not the outlying scattered houses. He keeps a diary showing how he has been employed each day, but does not keep any record of the sanitary state of the premises visited by him, or of the action required or taken for the abatement of nuisances.

Action of Rural Sanitary Authority in other parts of district.

The Rural Sanitary Authority have provided public water supplies for the populous places in the eastern portion of their district, including Charlestown, Watering Hill, Mount Charles, St. Blazey, and Tywardreath. Fowey is supplied by a company, but complaints are made that the quantity of the company's water is insufficient in summer, and that it is then eked out by water of doubtful purity.

A scheme for the joint supply of High Street (St. Stephens) and Trewoon (St. Mewan) has been long under consideration, but has recently been definitely abandoned. These places are very badly off for water; it has to be fetched long distances and obtained from an open stream liable to pollution.

A long correspondence has taken place between the Local Government Board and the Rural Sanitary Authority as to the water supply of Mevagissey, but has ended in the Authority declining to provide an improved supply.

The reasons which have prevented the carrying out of waterworks at different places have been the cost of the works, the difficulty in obtaining water rights owing to the demand for water at the clay works, and the opposition of the ratepayers, especially those in other parts of the parishes, who object to contribute to the cost of works from which they receive no benefit.

Little has been done in the way of drainage. Sewers are much needed at Watering Hill and Mount Charles (practically suburbs of St. Austell). There are none at present, and the liquid refuse from the houses stagnates in ditches, or runs down unpaved gutters by the road side.

No. 10.

Report on the Prevalence of Diphtheria at Kilkhampton, in the Stratton Rural Sanitary District, Cornwall; by Dr. Parsons.

This inspection, made on July 31st and August 1st, was undertaken under the orders of the Local Government Board, in compliance with the request of the Chairman of the Stratton Rural Sanitary Authority, in view of the continued prevalence of diphtheria in the village and neighbourhood of Kilkhampton.

Kilkhampton parish, the population of which in 1881 numbered 975, contains the village (which is somewhat compact, consisting of two or three streets), and a number of outlying farmhouses and cottages. The country is elevated and undulating; the village itself stands on high ground, but the outlying houses are frequently in damp hollows. The rock, locally called "shelf," is an alternation of sandstone and shale, of carboniferous age; the top soil is mostly clayey. The population is purely agricultural. The houses are fairly good, the chief fault being dampness. The floors are commonly of flagstones, and the eaves of the roof are rarely spouted. The interiors of the houses were generally found clean, but the surroundings of many of the outlying ones were far from cleanly, the yard in front containing accumulations of manure and stagnant water. Most of the houses have a garden or other open space at the back.

Kilkhampton village is partly sewered with glazed pipes. Another part, the Bideford Road, is drained by an open gutter in front of the houses; this gutter is about to be replaced by a pipe sewer. Other houses drain into ditches; at others waste water is poured on the gardens or ashpits. The drain inlets, where they exist, are outside the houses, but are not properly trapped. The closet accommodation consists of common privies or pail closets, sufficiently far from the houses. The water supply of Kilkhampton village is mostly from public pumps, and its quality is believed to be good. At some outlying cottages it is obtained from dipping wells obviously liable to be fouled by surface impurities. On the whole, I should regard Kilkhampton as being, as regards sanitary condition, better than the average of Cornish villages.

The origin of the outbreak of diphtheria in Kilkhampton is obscure. Two deaths from diphtheria occurred in that parish in 1887, but it is stated by the Medical Officer of Health that both of these cases were imported from elsewhere, and that no spread of the disease took place, though there were several cases in other parts of the district.

No case of diphtheria in Kilkhampton, nor indeed in any part of the Stratton rural district, was recorded in 1887, till December. In the earlier part of that month (the exact dates could not be obtained) cases of sore throat, apparently diphtheritic, occurred in two households in Kilkhampton parish, one in the village, the other at an outlying farmhouse at Lymsworthy.

In the latter household, five children, named Richards, suffered in December 1887 from sore throat, but as medical attendance was not called in, it cannot be definitely stated that the disease was diphtheria. The cases were mild, and all recovered. The first patient was a boy of 13, who was taken ill at Holsworthy market, whither he sometimes went (going there and back in the day). He had not been anywhere else out of the district. A lad of 13, named Cann, working by day at this farm, but sleeping at his home in the neighbourhood, went home

ill at this time with sore throat, and he is said to have had an ulcerated throat, with swelling of the glands in the neck. Two other Canns subsequently had sore throats, and one of these, a girl of four, died on December 25 of what was recognised as diphtheria.

As regards the household first invaded in the village, a child named Gilbert was taken ill with a mild attack of diphtheria about December 13th. She had attended the same school as some of the Richardses of Lymsworthy, at dates which would permit the idea that she contracted infection there. It deserves mention, however, that the mother has a chronic sore throat, which she says gets worse every autumn and breaks, and she thinks that it then affects the children. At the time of my visit the appearances presented by her throat were catarrh of the pharynx and enlarged ragged tonsils.

The next families affected with diphtheria, were, one in Kilkhampton village, for which Mrs. Gilbert washed, and one in an outlying farm-house, related to the last, and who had been to some extent in communication with them. It may be, therefore, that the disease was conveyed from one household to another by personal communication, though the dates of the known occasions of meeting, so far as were remembered, did not quite fit in with this view.

As to antecedent diphtheria in neighbouring districts, I learn from Mr. Linnington Ash, Medical Officer of Health in the Holsworthy district, that that district was free from diphtheria in the latter part of 1887. Under date June 15th, 1887, Mr. Ash records that an epidemic of sore throat of a suspicious character had been prevalant for some weeks in Pancrasweek (a village bordering on the Stratton district, and about three miles south-east of Lymsworthy). Many children had had it, and the village school closed by reason of non-attendance. The cases were numerous, but none were fatal. They partook more of the character of simple ulceration of the tonsils, with glandular swelling, than of diphtheria. The disease was decidedly infectious, but the medical men who attended some of the cases were unable to declare it to be diphtheritic. There were no cases in which symptoms of paralysis or of croup occurred.

A similar prevalence of sore throat, not presenting the appearances of diphtheria, but attacking several members of a family together or in rapid succession, occurred also at Kilkhampton at the time when diphtheria was present there.

In the Bideford Rural Sanitary District which adjoins the Stratton District on the north, diphtheria was somewhat prevalent in the winter of 1887–8, but the nearest places in the two districts at which diphtheria occurred were more than eight miles apart, and no connexion between the two outbreaks was elicited.

Subsequent to the above-mentioned cases in Kilkhampton, fresh cases continued to occur there up to the end of June; the greater number of cases having occurred in May and June. At the time of my visit it was hoped that the outbreak was over, no fresh household had been attacked for a month, and there were no patients then remaining under treatment. Up to that date there had occurred, so far as known, 40 cases recognised as diphtheria, in 19 households, with 10 deaths. Besides these, some 28 cases of throat affection where heard of which had occurred in the same houses as the diphtheria cases, or in households in communication with them, and there was a death certified as from "croup" in a household in which a case recognised as diphtheria occurred a few days afterwards.

In the above cases are included some which occurred in the parish of Morwenstow, but in outlying houses near the border of the parish of

Kilkhampton, and having all their communications—places of worship, schools, shopping, &c.—with the latter village. No case occurred outside the village in any household which had not communication with Kilkhampton, and hence it is probable that the disease was propagated chiefly by personal intercourse, though it was not possible in a good many instances to detect the exact channel by which the infection had been conveyed. School attendance does not seem to have had much to do with it, for in 13 out of the 19 households, the first case was not a child attending school. In several instances the case of diphtheria had been preceded, in persons associating with the patient, by cases of sore throat not recognised as of specific nature.

Water supply and milk supply were obtained from a number of different sources, and the outlying houses were not connected with one another or with the village by means of drainage.

Inquiries were made as to diseases among domestic animals, but none such were heard of except that at one house where diphtheria had been very severe two or three fowls had died, but from what cause, or whether at or near the time when diphtheria existed there, could not be learnt.

The preference of diphtheria for rural situations was illustrated in the present outbreak. Of the 19 houses invaded by the disease, 11 were in outlying situations, and in these occurred 29 cases and 10 deaths, whereas in eight houses invaded in Kilkhampton village there occurred only 11 cases and not one death, except the case previously referred to which was certified as "croup."

As regards sanitary condition, the outlying houses were, in general, in damper situations, and some of them had in front of them yards containing a quantity of manure, but in other respects they were not, as a rule, inferior to those in the village.

In one family at Burridge, consisting of man, wife, and seven children, there occurred eight cases of diphtheria with five deaths, the father of the family alone escaping the disease. The house was dilapidated and damp, being part of an old farmhouse divided into two cottages. In the other cottage also a fatal case of diphtheria occurred. Personal communication between the two households was denied, but the two houses were separated only by a board partition with open chinks. In the first family one of the children suffered from a second attack some weeks after recovery from the former.

The following are other points of interest:—

In two cases it was believed locally that the period of incubation was as long as 14 days. In one instance, a woman going into Kilkhampton from an outlying house left one of her children at the house of her sister who had a boy then lying ill of diphtheria. The child was found there by Mr. Braund, the Medical Officer of Health. Fourteen days later this child was attacked with diphtheria. In the other instance there seemed to have been other opportunities of contracting infection subsequent to the one a fortnight before.

In two households diphtheria seems to have been associated with scarlet fever. The two households were affected about the same time, and the children of the two were suspected to have met. In one of these households the first case is stated to have begun as diphtheria, having a small white patch on the tonsil with external swelling; in about a fortnight a scarlet rash broke out. A second and third case of diphtheria followed, both mild and with no rash. These were followed in two other members of the family by attacks of scarlet fever, without diphtheritic membrane, and off one patient the skin was still peeling at the time of my visit.

In the other family a servant lad had "ordinary sore throat," with a little redness about the tonsils, but no rash. A few days after, a girl of 11 was taken ill with vomiting, headache, and sore throat; a scarlet rash appeared on the third day and was followed by copious peeling, but there was also a deposit of diphtheritic membrane on the throat. The attack was followed by one of rheumatism. A younger child had a slighter attack.

In not a single case in the present outbreak has diphtheria been followed by paralytic symptoms, whereas the Medical Officer of Health, Mr. Braund, informs me that in an epidemic of diphtheria which occurred in the district 30 years ago, many of the cases were followed by local forms of paralysis. I myself have noticed great differences between different outbreaks of diphtheria as regards the frequency with which such sequelæ occur.

The Rural Sanitary Authority and their officers appear to have been active in using such means as were at hand to prevent the extension of the outbreak, but they have no hospital for the isolation of infectious cases. Infected houses have been fumigated, cleansed, and lime-washed, and articles of clothing washed and disinfected, or in some cases burnt. In one household diphtheria recurred after the lapse of some months, the house having been carefully purified after the first outbreak, but the recurrence may have been due to a re-introduction of infection.

There are two public elementary schools in Kilkhampton. These were closed at the request of the Sanitary Authority from May 4th; they re-opened for one or two weeks in June, but diphtheria being still prevalent they were closed again until the end of July; at the time of my visit they had just re-opened. During the time that the schools were open, care was taken to exclude children from households known to be infected with diphtheria, but children from households affected with sore throats in some cases continued to attend. I advised the Medical Officer of Health and the masters of the schools that during the prevalence of diphtheria all sore throats among children, especially when several members of a family were affected at one time, should be regarded with suspicion, and I left with them copies of the office memorandum on the concern of schools with the spread of infectious diseases. I also suggested that in the event of diphtheria recurring, there might be advantage in hiring a cottage as a "temporary place for "the reception of the sick" (Section 131, Public Health Act): so that when diphtheria broke out in a family, the sick person could be at once separated from the healthy members. In this way the occurrence of such a calamity as that at Burridge might have been prevented, for there, as indeed was commonly the case in Kilkhampton, the invaded cottage afforded no facilities for such separation.

No. 11.

Report on an Epidemic of Diphtheria in the Urban Sanitary District of Midsomer Norton, Somersetshire; by Dr. Blaxall.

The Board, having received information from Dr. Waugh, Medical Officer of Health, of the outbreak of diphtheria in the Urban Sanitary District of Midsomer Norton, instructed me to make inquiry into the particulars connected with the outbreak.

I visited Midsomer Norton on the 24th of May, and learned from Dr. Waugh and Dr. Blacker that the first recognised case of "Diphtheria" was one that came under Dr. Blacker's care on the 30th of April, and proved fatal on the 2nd of May; that a second case followed in the same house about the 4th of May, and also proved fatal; and that from the beginning of May to the date of my visit (24th May) 15 fresh houses had been invaded with 16 cases, four of which had proved fatal, making in all 16 families attacked, and a total of 18 cases, with six deaths. The bulk of the cases occurred in children attending the "Chapel School," and Dr. Waugh, recognising the school as the channel disseminating the disease, had judiciously advised the closing of all schools. Dr. Waugh had not met with any special prevalence of sore-throat or mumps, but Dr. Blacker had observed a good deal of sore-throat, ulcerative in character and specially offensive, prevalent during the winter months. Further, "Diphtheria," as will be presently shown, had prevailed extensively from the previous August to February at Timsbury, a somewhat large village some 3 miles to the north, and also in February and March at Dunkerton, a village some 4 miles to the north-east of Midsomer Norton.

At this stage of my inquiry, it became necessary to leave Midsomer Norton for other office engagements; and before leaving I was at pains to urge the adoption of means for detecting all cases of diphtheria at their earliest stages, and for procuring the efficient isolation of such cases and disinfection of their belongings. But on my return, on June 8th, I found that the Sanitary Authority had not seen their way to providing for themselves the desired means of isolation.

I now proceed to such account of the circumstances of this urban district, and of the prevalence of diphtheria there, as I was able to obtain after a somewhat more lengthened investigation.

Midsomer Norton is a large parish situated on the eastern side of the Mendip Hills, and covering an area of 3,922 acres. The population amounts to about 4,420 persons, of whom more than half reside in the village of Midsomer Norton, the remainder in the hamlets of Wilton,

Clandown, Radford, Downside, and Clapton. The population is mainly employed in neighbouring coalmines; and not a few of the men travel some miles daily to and from the various pits. Geologically the district comprises dolomitic conglomerate, new red marl, lower lias clay and limestone, and inferior oolite.

The village of Midsomer Norton, with which this report is mainly concerned, stands on the new red marl, in a valley, having a wide brook, the "Somer," running down the side of the main street. *The water supply* is derived chiefly from springs at Chilcompton, the water being brought down by gravitation and pretty generally distributed throughout the village. I met, however, with instances where families were dependent upon wells for their drinking water, or upon springs which, in the hot season, were liable to run dry; as, for example, at Clay Batch, where the occupants of seven dwellings are put to great straits in the summer to get water for their daily use. Some of the wells are evidently exposed to dangerous pollution, as at Rackfarnal Villas, where the water is derived from a well sunk about 12 feet or so from a privy cesspit; and again at Gunning's Houses, where a butt-ended stop drain runs close to the well. *Excrement removal and disposal* are mainly effected by sewers, but the drains of closets are habitually unprovided with means for flushing, except by hand labour, and this is not infrequently neglected, with the customary result of blocking the drains with decomposing excrement. Further, bad examples of cesspit privies came under notice in the village and elsewhere. The *system of sewers* consists of brick culverts and glazed pipes. These latter are laid with clay joints, and the Surveyor tells me the Authority are now experiencing trouble from the sewers opening at the joints and taking in subsoil water. The sewage is disposed of by filtration, and the effluent water discharged into the brook, which then continues its course to Radstock, where the Radstock Authority complain that its polluted condition causes considerable nuisance. To remedy this evil the Midsomer Norton Authority applied to the Board for powers to borrow money to carry out projected improvements, and the Board have held inquiry on the subject. The ventilation of the sewers is very inefficient; when first laid down, street ventilators were provided, but these have been done away with, and 2-inch shafts substituted, and of these only seven have been provided for some two miles of sewers. *Removal of house refuse* is left to the householders to carry out, and is not infrequently neglected, as evidenced by the accumulations met with at various places in the course of my inquiry. The Authority have adopted the model byelaws for the regulation of *slaughter-houses*, but certain of the more important provisions are not enforced; for example, no one of the three slaughter-houses is provided with closed vessels for the removal of blood and offal as required by the byelaws, and it was admitted that all the blood from one of the slaughter-houses passed into the sewers. Near another I saw animal refuse collected in a manner to befoul the brook, and during my inquiry I received repeated information of the brook being at times polluted by these means.

Diphtheria and Sorethroat.—I received from Dr. Waugh and Dr. Blacker information of 27 families that had suffered from diphtheria or from suspicious sorethroat, resulting in all in 40 cases and 6 deaths. Multiple cases, from two to four, had occurred in nine of the families.

The first recognised cases of diphtheria, referred to at the commencement of this report, occurred in two sisters who attended the Chapel School up to 27th of April, on which day one of them was taken ill. Dr. Blacker was sent for on the 30th, when he found her suffering from

diphtheria, and she died on the 2nd of May. Her sister was attacked on or about 4th May and died on the 10th. These two cases were quickly followed by others among the Chapel School-going children, three cases ending fatally on the 11th, 12th, and 13th of May respectively, causing alarm in the village, and as the sufferers were all school-going children, the schools were, under the advice of Dr. Waugh, closed after Friday, May 11th.

I extended my inquiries beyond the 27 infected families to some 100 or more other families for the sake of understanding what circumstance or condition might have been specially operative on the infected households in contradistinction to those that escaped the disease.

Of the 27 infected families 15 resided in the village of Midsomer Norton, but their dwellings were often widely apart; the remaining 12 families were scattered about the district.

In 14 out of the 15 families that were first attacked, the disease commenced in the person of a child attending school, in 13 instances attending the Chapel School, in one instance attending the Church School at Midsomer Norton. In the fifteenth family the disease occurred in the person of a man living at Clapton, who was attacked on May 3rd, and of whom mention will presently be made. For a while the disease was confined to these 15 families, but later it extended to other 12 families, as to which in no case did the first sufferer attend any school.

Inquiry went to show that diphtheria, though not recognised as such at the time, was undoubtedly present among the Chapel School children prior to the occurrence of the above-mentioned case of the 27th April; and cases of suspicious sorethroat of the same earlier date were also heard of. The following are particulars of such illness in various households:—

A. L., aged 5, was in attendance at the Chapel School up to April 13th, when she complained of sorethroat, and her mother kept her at home till April 30th. She did not have a medical attendant, but her mother describes her attack to me as showing burning heat, with great discharge from her nose and swelling of the glands of the neck. I saw the child myself on the 8th of June, two months after the date of attack, when I found her suffering from a paralysis, affecting voice and deglutition, characteristic of that which follows diphtheria. No other case occurred in this family. It consists of father, mother, and four other children, three of whom continued to go to the Chapel School during their sister's illness. A. L. returned to school on April 30th, and it is noteworthy that during the following five or six days six fresh cases of diphtheria occurred in the school, four of them in the infant class, to which this little girl A. L. belonged.

S. M., aged 8, was attacked with sorethroat of a suspicious character on the 18th of April, and her mother kept her at home till the 30th April; her sister, M. M. aged 5, continued to attend school, and was attacked with diphtheria on May 3rd. Whether the origin of this case was by infection from S. M., or by infection contracted at school, is not clear; seeing that this child was one of the four cases above-mentioned as occurring in the infant class to which A. L. returned on the 30th April. I saw the child M. M. on the 24th of May, and again on the 18th of June, when she was a pitiable object from diphtheritic paralysis, head bowed down, voice so much affected as to be scarcely intelligible, hands tremulous, and gait very tottering. Prior to S. M.'s attack of sorethroat on the 18th of April, her married brother and his wife, living in another part of the village, had both suffered from sorethroats to which the man was subject.

T. G., aged 8, was absent from the Chapel School from the 9th to the 17th of April, and his sister from the 17th to the 29th of April, both suffering from sorethroat.

A. H., aged 8, was absent from the 30th of March to the 8th of April, suffering from an illness that was said to be "like Mumps." At the same time his sister, aged $3\frac{1}{2}$, was very ill with vomiting, headache, and slight sorethroat.

Here, then, we have sorethroat of a suspicious character present in the Chapel School prior to the first *recognised* case of diphtheria on the 27th of April; a child recovering from diphtheria, returning to school on the 30th of April whilst in an infective condition, and during her illness three of the infected family continuing to attend school so that ample opportunities were afforded for inter-communication between infected and healthy both at the school and going to and from school, before the time came when the prevalence of diphtheria forced itself into notice. With regard to the 13 invaded families in which the primary attacks were not in the persons of school-going children, in three such primary attacks communication with previously infected families was clearly made out, but in the remaining 10 families such communication could not be established. Six out of the 10 first sufferers in these families were adults.

The man at Clapton, the earliest sufferer in any family whose children were not attending school, may have been exposed to chance infection during a journey four days before his attack, but no diphtheria is known of at the village in Dorsetshire to which he travelled. In one of these later invasions, the first member of the family to suffer was a man who had been away from home shortly before; and the third was in an acquaintance of his who had a child at the Chapel School, but who became ill before his child was attacked.

Beyond such intercommunications of the infected and healthy as are recorded above, I have been unable, in spite of careful investigation into the circumstances and conditions under which the people lived, to obtain any clue as to the manner of dissemination of the disease. Certain of the sufferers had previously to their attacks been subject to sorethroat, but this was by no means general. There was no community of milk, water, or other food supply amongst the infected. Animals, fowls, or other birds cannot be supposed to have played any part in the origin or spread of the disease, for as a rule, none were kept, and at places where they were kept there was no evidence of their having been unhealthy. Neither, so far as I could learn, had there been any previous disease amongst cattle in the neighbourhood.

As already observed, the disease was at first almost entirely confined to Chapel School children; and this circumstance might lead to a suspicion that the school had been concerned in the origin, as well as in the spread of the disease. The drainage of the school was not satisfactory, nor indeed were the closets, but these conditions at the school were indistinguishable from those observed throughout the village. Running near the school was an offensive open drain conveying water from the gasworks, but again, the nuisance arising from this source was common to the Chapel School and to many dwellings not invaded by diphtheria. Further, if the school had been inculpated in the original production of the disease, we should in all probability have witnessed a larger and more simultaneous outbreak amongst the school children.

But there were 342 children attending the Chapel School, and so far as could be learned, the attacks were of one child only on 13th April, a second child on the 27th of April, and an outbreak of not more than some six cases shortly after the return to school of one of the infected children on the 30th of April. So that I do not find the sanitary defects of the school to be responsible for the disease, otherwise than

as close schoolrooms may have been adapted to facilitate personal infection.

The parents of some of the infected children complained loudly of the nuisances to which they were exposed from the polluted state of the brook Somer, also of blockage of closet drains and accumulations of refuse near their dwellings, and they were inclined to ascribe their children's illness to these conditions. But while these several evils formed just ground of complaint urgently demanding amendment, the occurrence of diphtheria cannot be connected with them as effect to cause; seeing that the sick persons were only a few out of a large number of children and adults exposed to the same influences.

With regard to the origin of diphtheria in the important case of the child A. L., she lived at Rackfarnal Villas, where the water supply, as before stated, was exposed to pollution, but inasmuch as this was the only case that occurred amongst 15 children and adults deriving their drinking water from the same supply, the origin of the case cannot be ascribed to drinking this water. And this child in her turn had previously been in relations with sore-throats, in the persons of her schoolfellows.

The existence of the cases of suspicious sorethroat at the Chapel School has been traced back to March last, and though it is true that their relation to the diphtheria which forms the subject of this report cannot be established; yet the pre-existence of these cases at the school and elsewhere in the neighbourhood cannot be left out of account. The Registrar-General's returns of mortality for the previous half-year show five deaths from diphtheria in the Clutton Registration district, four of them in the Clutton sub-district, and one in the Midsomer Norton sub-district. Mr. Crang, Medical Practitioner of Timsbury, in the Clutton sub-district, informs me that diphtheria prevailed in his practice from September 1887 to February 1888; that he had some 50 cases or more at Timsbury, and several cases at Camerton, Carnicot, Lumley, Radford, and Farnborough, but, he added, the disease was of a mild type.

Dr. Wilson, Medical Officer of Health for the Clutton Rural Sanitary District, says diphtheria and suspicious sorethroat commenced in Timsbury in August 1887, became very prevalent in the winter months, and continued till February, when the last death from diphtheria was registered there. Mr. Harper, Medical Officer of Health of the Bath Rural Sanitary District, reports a severe epidemic of diphtheria in the parish of Dunkerton, from February to March 1888, and upon good grounds he ascribes the origin to an introduction from Timsbury. Upon the Dunkerton epidemic, followed the epidemic at Midsomer Norton. Thus it would appear that there has been an epidemic prevalence of diphtheria for some eight or nine months over a somewhat wide area, embracing villages and hamlets in various adjoining parishes. This prevalence suggests no geological influence, as the formations are very varied; nor does it suggest any aërial distribution, since certain of the places are separated from each other by high hills.

In short, the history would appear to be this:—Diphtheria first showing itself as an epidemic at Timsbury, is traceable from thence to place after place until it arrived at Midsomer Norton. There, it is true, communication with antecedent cases of diphtheria cannot be established, but it is reasonable to infer that, unless the disease were carried directly through the atmosphere over considerable distances and across high hills, it spread by unrecognised intercommunication with infected persons. That it could have thus spread without the knowledge of the persons concerned is seen to be probable enough when we note the nondescript sorethroats and "Mumps" that prevailed at certain periods,

and which may well have played a part in the spread of the disease. It may be a question whether these cases of sorethroat afford examples of progressive development of sorethroat into diphtheria which has been spoken of by certain authorities. I see, however, no evidence in favour of this hypothesis, observing that cases of sorethroat, however trivial, are shown to be already of diphtheritic nature, if they are followed by the characteristic paralysis of the disease.

No. 12.

Report on a Prevalence of Diphtheria in the Camelford Rural Sanitary District; by Dr. Ballard.

There were two bases for this inquiry:—one the record in the Registrar-General's Returns for the second quarter of 1888 of four deaths from diphtheria in the Camelford sub-district of the Camelford Registration District; the other the annual report for 1887 of Mr. Pearce, the Medical Officer of Health for this portion of the Camelford Rural District, in which were tabulated 14 deaths from "croup" without mention of diphtheria. Suspicion thus arose that these 14 deaths from so-called "croup" had been deaths from diphtheria, and that this disease had been prevailing in the district much more extensively and for a much longer period of time than the above official documents indicated. Accordingly I was directed to inquire whether this "croup" had been diphtheria, and, if so, what steps the Medical Officer of Health had advised the Local Authority to take for arresting its spread and preventing its recurrence, and what had been the action of the Local Authority thereupon. Concurrently I was to ascertain what I could as to the circumstances or conditions under which the diphtheria (if the malady in question had been diphtheria) had originated and spread.

The first of the above questions was quickly set at rest. On applying to Mr. Pearce, the Medical Officer of Health of the Camelford division of the Rural Sanitary District, I was brought into communication with his partner, Dr. Jerome who, having attended most of the cases, had generally certified the cause of death; he at once told me that he made no distinction between "croup" and "diphtheria," and that he regarded these terms as synonymous. Mr. Pearce too had similarly used the terms indifferently, and thus it had come about that up to the date of my inquiry almost all the current fatal diphtheria in the district had knowingly been registered as "croup." The suspicion therefore that diphtheria had been prevailing for a long time in the sub-district of Camelford, much longer than was apparent from the official reports, become fully confirmed. [The present report will accordingly use the word "diphtheria" as inclusive of "croup."]

The next point for determination was the length of time during which this disease had prevailed in the district, and with this object I made examination of the death registers in the Camelford sub-district, searching them back to 1884. The subjoined tables A. 1 and A. 2 exhibit numerically and in rates per 10,000 of population the progress of fatal diphtheria in the sub-district, and in each of its contained parishes, quarter by quarter during the $4\frac{1}{2}$ years, 1st January 1884 to 30th June 1888. And in table C.* appended to this report will be found other facts, extracted by me from the registers, set out in some detail.

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* Not here reproduced.

TABLE A. 1, showing Quarter by Quarter the DEATHS from DIPHTHERIA in the CAMELFORD SUB-DISTRICT and in each of four of its contained Parishes during the 4½ years, 1st January 1884 to 30th June 1888.

Parish.	1884. Quarters.				1885. Quarters.				1886. Quarters.				1887. Quarters.				1888. Quarters.	
	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.
St. Teath - -	—	—	—	5	—	—	4	3	1	—	4	1	—	1	2	5	—	6
Lantiglos - -	—	—	—	—	—	—	—	—	1	—	—	—	4*	2	2	—	1	—
Michaelstow -	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—
St. Breward - -	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Whole sub-district -		—	1	5	—	—	5	3	2	—	4	1	4	3	4	5	3	6

* Including one case registered as "laryngitis."

TABLE A. 2, giving Quarter by Quarter the DIPHTHERIA DEATH RATES (per 10,000 Population) of the CAMELFORD SUB-DISTRICT and of each of four of its contained Parishes during the $4\frac{1}{2}$ years, 1st January 1884 to 30th June 1888.

Parish.	Population (1881).	1884. Quarters.				1885. Quarters.				1886. Quarters.				1887. Quarters.				1888. Quarters.	
		1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.
St. Teath -	1,994	—	—	—	25·1	—	—	20·0	15·0	5·0	—	20·0	5·0	—	5·0	10·0	25·1	—	30·0
Lantiglos -	1,524	—	—	—	—	—	—	—	—	6·6	—	—	—	26·0	13·0	13·0	—	6·6	—
Michaelstow -	222	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	90·0	—
St. Breward -	728	—	—	13·7	—	—	—	13·7	—	—	—	—	—	—	—	—	—	—	—
Whole sub-district	5,312	—	—	1·9	9·4	—	—	9·4	5·6	3·8	—	7·5	1·9	7·5	5·6	7·5	9·4	5·6	11·3
		11·3				15·0				13·2				30·0				16·9	

Here then there was occurring for a period of over four years fatal case after fatal case of what was known by the Medical Officer of Health to be diphtheria; cases at first met with only in the latter part of each year, subsequently in the first quarter also, and from the middle of 1886 to the middle of 1888 becoming not only more and more numerous, but occurring every quarter without exception up to the time of my inquiry. On the whole there had by that date occurred 46 fatal cases, of which all but three had been under the professional care of the Medical Officer of Health or of his partner.

The fatal cases of 1884 occurred with a single exception in Church Town, St. Teath (the village of St. Teath). In 1885 all but one occurred in another part of the same parish, namely, in or about Delabole, in the neighbourhood of the celebrated slate quarries. Medrose, Pengelly, Rockhead, &c., are different parts of Delabole, which is altogether the most populous part of St. Teath parish, and has a church and board school of its own. In 1886 of the six deaths in St. Teath parish all but one occurred at Delabole; the single death in Lantiglos parish occurred in the town of Camelford. In 1887 of the eight deaths in St. Teath parish six again were at Delabole, one only at St. Teath village, and one in another part of the parish. But in the same year eight fatal cases occurred in Lantiglos parish, of which three were in the town of Camelford and three in a place called Trewalder, at no great distance from Delabole quarries. In 1888, of the six fatal cases in St. Teath parish, five were again at Delabole. From the middle of 1885 then up to the middle of 1888 the disease prevailed fatally chiefly at Delabole and in its neighbourhood.

I found it quite impossible to discover what amount of diphtheritic disease these 46 fatal cases represented, but it most probably was very large. Whatever the amount was, so far as the cases received medical care at all, that care must, in all but a few exceptional instances, have been bestowed by Mr. Pearce and his partner, since they are the only medical practitioners resident in the sub-district. No record however had been kept of the cases attended by the firm, the reason assigned being that it had "a large contract practice." Mr. Pearce added that "there were many cases which had no medical attendance whatever." It is obvious that under such circumstances any attempt on my part to define precisely the mode of introduction of the disease into the places attacked and the way in which it spread would have been futile. No cases were in progress at the time of my visit, and hence the utmost I could do was to note the sanitary conditions generally present in this district, especially the conditions at Delabole and St. Teath village and at some of the individual houses where cases fatal or non-fatal had occurred.

The general outcome of inspection to this end was as follows:—

1. One unwholesome condition is observable almost universally, namely, dampness of the walls of dwelling-houses, and especially of workmen's and labourers' cottages. This is due to two causes: one of these is absence of spouting at the eaves, and the other is the fact that the dwellings are generally constructed of irregular shaped slabby pieces of slate rock, the refuse of the quarries, laid often in such a way that rain beating on the wall outside tends to run downwards towards the inside of the dwelling; further the mortar used having been made with sea sand is consequently absorbent and retentive of water. Hence it is not only the basements of houses which are apt to be damp, but the bedrooms also. Delabole stands high, rain is abundant and wind often violent in the winter, so that walls thus constructed readily get soaked through and dry but tardily.

2. Setting aside the town of Camelford, which it appears has been pipe drained, there is observable generally in the district an absence of systematic and efficient drainage. What drainage has been attempted at Delabole and St. Teath village has been of a scrappy character, and often has consisted in the construction in the main roads of square flat bottomed superficial drains of slate. As to domestic premises, private drainage has been universally or almost universally neglected. Generally in Delabole and St. Teath the condition of the private drainage is about as bad and unsatisfactory as drainage can be. What supervision is exercised over drainage work is exercised by the Inspector of Nuisances.
3. "Nuisances" as defined by the 91st section of the Public Health Act receive but scant attention as respects removal or abatement, and it may fairly be said none at all with a view to prevention. Certainly no effort is made to search them out, some most obvious and glaring ones having been persistently overlooked. Hence nuisances abound. I scarcely see how it can be otherwise, since, as I understand, the one man who is Inspector of Nuisances for the whole district of 51,866 acres is Surveyor of Roads for the entire district also.
4. Many cottages are without any privy accommodation. In these instances the common practice is to empty excrement out of domestic vessels upon a midden heap, sometimes close to the house, raking some ashes over it to obscure its offensiveness. This occurs not in the case of isolated cottages only but even in such villages as Delabole and St. Teath.
5. The water supplies in many instances are liable to dangerous pollution. Dr. Jerome, who accompanied me in my inspection of the sub-district, pointed out several wells supplying dwellings, both isolated and situated in the villages and hamlets, which had been sunk in a porous soil within a few feet of undrained stables, cowsheds, or the like. He considered some outbreaks of diphtheria in houses so supplied with water to have been due to the drinking of water of such wells.
6. One redeeming feature of the district must however be mentioned. I allude to the remarkable cleanliness which I observed in the interior of the dwellings of the labouring class. Persons of this class evidently aim habitually at cleanliness and neatness of themselves and their children, as well as at domestic cleanliness and neatness. Both are examplary. However damp the slate floor might be, and however damp the walls might be, all was usually clean within, and the women and children clean and neat also. Such people deserve the aid of their Sanitary Authority in maintaining cleanly surroundings for their houses.

The Medical Officer of Health of this Division of the Camelford Rural Sanitary District, Mr. Pearce, keeps a report book which is laid before the Sanitary Authority at their meetings. He is required to enter in it all such matters as concern the sanitary condition of his district, with such recommendations for improvement and for the prevention and arrest of disease as appear to him to be requisite. I submit herewith for the Board's information all the references to diphtheria or to croup that I can find in this report book from the beginning of 1884 to the time of my inspection.* Looking to an entry dated January 20th, 1888, it appears that the Medical Officer of Health had been for years aware that a form of disease new to the neighbourhood, and of a fatal character, was prevailing largely and

* Not here reproduced.

spreading extensively. Nevertheless I do not find evidence that he made any serious attempt to seek out the causes of its sustained prevalence; indeed the disease would appear to have been left pretty much to go its own way. On inquiry of the Inspector of Nuisances whether anything had been done in the way of disinfection of dwellings or articles of clothing, he informed me that, neither in respect of this disease nor in respect of any other disease, had he ever since he had been in office (four years) been directed either to make or to superintend any. Isolation was of course out of the question, since the Sanitary Authority have not provided a hospital for the purpose. In a word, there seems to have been a general contentment with things as they were. For all this it is difficult to blame the Sanitary Authority, whom it was the plain duty of the Medical Officer of Health to inform and advise.

There have during the past few years been a smaller number of fatal cases of diphtheria in the other, the Boscastle Division of the Rural Sanitary District, the Medical Officer of Health for which is Mr. Wade. Table B. on next page gives a list of these other fatal cases.

In company with Mr. Wade, I visited each of the places where the deaths recorded in this table occurred. All of them are situated in the most elevated parts of the district, which are very scantily populated. The two most populous villages or small towns in the Division, Boscastle and Trevena, escaped with the exception of two cases, which recovered, at a part of Boscastle named Forrabury.

"Cairo" is an isolated farmhouse of the better class. The first child attacked here went to a private school at Marsh Gate where some of the inmates are believed to have had at the time diphtheria, or certainly some throat affection. The dwelling-house at Cairo is damp from the foundation. The farm premises are without any proper drainage, and the farmyard close to the dwelling is consequently filthy from sewage running over its unpaved surface to some ditches at the rear. At the time of the illness there were close to the well from which water for all domestic uses was drawn, a stable and piggeries which have since been removed. Nothing further appears to have been done, either in the way of isolation of the sick or for improvement of the premises. Mr. Wade tells me that there had been diphtheria in this house 25 years before.

"Trela" is also an isolated farmhouse of the better class. The child who died here did not go to school, but others of the family, who are said to have remained perfectly well, did go to school at Camelford. The day after the child's death an aunt aged 26 years residing in the house was similarly attacked but recovered. None of the animals on the farm were sick. The house is dry, both as to floor and walls. The drainage outside in the adjacent farmyard is as bad as at Cairo, and a piggery stands at an inconsiderable distance from the house. About 50 yards off is a most filthy ditch, into which the sewage of the domestic premises finds its way, and where it stagnates. The pump-well used for all domestic purposes is in a washhouse within the dwelling, and the slate paving about it is bad and dilapidated. Nothing appears to have been attempted here in the way of improvement.

"Beslow" is a pair of labourers' cottages, one of which was unoccupied and in disrepair, situated at a considerable elevation near the village of Trebarwith, where Mr. Wade states no cases have occurred. Three children had diphtheria in the house; only one recovered. The eldest of them, who was the first attacked, attended the Delabole Board School, but had not been at school for a fortnight before being taken ill. Other children from the village of Trebarwith attended the same school but escaped illness. The house is dry, both as regards its slate floor and walls, but the small yard in front of it is very wet in the

TABLE B. showing the DEATHS from DIPHTHERIA (and "CROUP") in the BOSCASTLE SUB-DISTRICT in the 3½ Years 1st January 1885 to 30th June 1888.

When died.	Name.	Sex.	Age.	Parent's Rank.	Disease as Registered.	Residence.	Certified by
1885. Aug. 23	Eliz. Venning	F.	6 years	Farmer	Diphtheria, 6 days	Cairo, Otterham	Wade.
Sept. 4	Edw. Venning	M.	2 „	Farmer (same family)	„ 10 „	„ „	„
„ 18	Prudence Mary Venning	F.	4 „	Farmer (same family)	„ 14 „	„ „	„
1886. May 11	Sidney Wickett	M.	3 „	Farmer	Croup	Trela, Minster	„
1887. Dec. 5	Bessie Jane Skinner	F.	6 „	Slate quarrier	Diphtheria	Beslow, Tintagel	Jerome.
„ 15	Laura Skinner	F.	4 „	„ „	„ 7 days	„ „	„
1888. Mar. 10	Wm. Jas. Croker	M.	4 „	Master carpenter	„ 7 „	Hellsett, Lesnewth	Wade.

winter "from springs." And close by, within a few yards, there was a considerable patch of boggy land, since well filled in with slate rubbish. The water supply is from a roadside shallow dip-well fairly elevated above the road. The interior of the house is clean and neat.

"Helsett" consists of a block of three cottages situated rather in a hollow, and so grouped together as that no one of them has through ventilation. A single case of diphtheria occurred in one of these cottages now untenanted. Mr. Wade says that a death from scarlatina occurred in one of the other cottages two months subsequently. The adjacent yard is very ill drained and dirty, and the sewage of all three dwellings runs into a filthy ditch in an adjoining enclosure. The well is situated in the yard close against the wall of one of the cottages. The occupants of the cottages say that they use its water for drinking in the winter; but in the summer not until it has been boiled, as "it is not good." Nothing appears to have been done for the improvement of these premises.

Mr. Wade is required to keep a report book, but it contained no entry since June 1884. But he tells me that he has since that date reported verbally to the Sanitary Authority. On looking through the minute book of the Sanitary Authority I find one entry only about diphtheria, and that under the date September 4th, 1885, viz.:—"Dr. Wade "reported five cases of diphtheria, and three deaths at Cairo, and two "cases at Forrabury, and one in Minster."

So far as sanitary administration is concerned, there would appear little to choose between the Boscastle and the Camelford divisions of the Camelford Rural Sanitary District.

The Board have recently had a report from Dr. Parsons on a prevalence of diphtheria in the Stratton Rural Sanitary District, which adjoins the Camelford Rural Sanitary District on the north.* While myself engaged later on vaccination inspection in the Bodmin Union, which adjoins the Camelford Union on the south, I took the opportunity of inquiring as to any recent prevalence of the disease in that district. I first inquired of Dr. Cole, District Medical Officer and Public Vaccinator for that part of Bodmin immediately adjacent to the Camelford sub-district, and he obligingly furnished me with a list of some of the cases which he himself had attended. It is clear from this list, that during the time that diphtheria was prevailing in St. Teath and other parishes of the Camelford sub-district, it was also prevalent in neighbouring parishes of the Bodmin (northern part) District, especially during 1887–1888, viz., in St. Kew and in St. Mabyn parishes. When I was in Bodmin town, I inquired also of Mr. T. Mudge, the Medical Officer of Health of the Bodmin Rural Sanitary District, and he was good enough to furnish me with a list of fatal cases of diphtheria that had occurred in his district from the commencement of 1885, and also with extracts from his report book relating to this disease from the same date. These documents I forward for the Board's information. The Medical Officer of Health of the Bodmin Urban Sanitary District, informed me that during the whole period that town had been free from diphtheria; the disease having been limited to the less densely populated parts of the Union.

One inference that may be drawn from Dr. Parsons's report and these documents taken together is, that diphtheria has been unusually prevalent over the north-eastern borders of Cornwall ever since 1885.

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* Reprinted as Appendix A. No. 10 of present volume.

No. 13.

App. A. No. 13.

On Diphtheria in Aylesbury; by Mr. Spear.

Report on Diphtheria Prevalence in the Aylesbury Urban Sanitary District; by Mr. John Spear.

Part I.—Diphtheria Prevalence.

Previous inquiry.

In February 1886 Dr. Gresswell made inquiry on behalf of the Board into a high mortality from diphtheria in Aylesbury. An epidemic prevalence of the disease had lasted from the middle of the previous October, and at the time of his visit was still continuing. The schools of the town had, it appeared, been largely concerned in the spread, if not in the development, of diphtheria. Out of 37 household invasions recognised since the commencement of the outbreak, the first sufferer had in 30 cases been attending one or other of three public elementary schools within two days of falling ill; and, further, ulcerative sore-throat, to which Dr. Gresswell was disposed to attribute a part in the elaboration of diphtheria, had prevailed amongst the children attending one of these schools before the latter disease was recognised.

Recent mortality from Diphtheria.

Information contained in Dr. Gresswell's report regarding the recent annual mortality from diphtheria is brought up to date in the table below.

Table I.—Deaths from Diphtheria in Aylesbury.

Years -	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Four Months, 1888.
Deaths -	0	1	5	1	0	15	16	27	5

Note.—One of the five deaths in 1888 was registered as due to scarlatina, but was afterwards recognised as from diphtheria.

In addition to the above, two deaths were registered as due to "croup" in 1887, and one in March 1888 (these all occurring in neighbouring houses). In 1887 the death of an infant, in a house in which diphtheria prevailed, was registered from "convulsions." In 1887–88 the deaths of two infants from "bronchitis" were registered in families in which diphtheria made its appearance within six days and within two days respectively; in June 1887 the death of a child, aged 14, was registered as from "measles, ulceration of fauces, laryngitis," from a family in which a death from diphtheria had occurred seven days before; and in March 1888 one from "acute laryngitis" in a family that had suffered from diphtheria in the previous December.

It will be seen that the average annual death rate from diphtheria in the five years 1880–84 was equal to ·17 per 1,000 of the estimated population of 8,000, or slightly higher than the average diphtheria rate of England and Wales; but in the three years and four months following, the annual average was 2·2 per 1,000 of the then estimated population, or 13 times the previous rate, and in 1887 it was as high as

3·2. My own inquiry then has been concerned with a long standing and increasing prevalence of the disease.

This prevalence has not, however, been continuous, and the seasonal incidence of the disease has been marked. The epidemic of 1885–86, the first part of which was reported upon by Dr. Gresswell, commenced in October and lasted until the end of the following March, after which the disease extended but slowly until June. From the 15th of July until the following April (1887) no death from diphtheria was registered, and so far as I can ascertain non-fatal cases occurred in only three widely separated houses.* The fact of this intermission may at least be affirmed as regards *recognised* diphtheria. As to the possibility of mild and hidden cases maintaining a continuous chain of infection, it is certainly true that "simple sore-throat" had prevailed throughout the winter of 1886–87; catarrhal rhinitis, likewise, with some offensive discharge, has been spoken of to me as common during this period. But as to the diphtheritic nature of the catarrhal affections that were thus interposed, the absence throughout a long series of cases of the distinctive appearances of diphtheria, the freedom from fatality and from characteristic sequelæ, must be allowed weight. On the other hand, when diphtheria prevalence was again established, although that of "simple sore-throat" had been diminished, several cases of illness occurred not distinguishable, it is said, from the apparently simple affection, except for characteristic sequelæ; and here and there unequivocal cases of diphtheria were associated, apparently causally, with attacks that from a clinical standpoint alone would be considered non-specific. The possibility, suggested by Dr. Thorne, of *potential* and gradually developing specificity attaching to an apparently benign disease has likewise to be considered; and as to this the importance of negative testimony, such as that above referred to, deducible from long continued abcence of fatality, &c., is certainly discounted on finding that, as regards unequivocal diphtheria, *virulence* is a quality subject to seasonal variation. In the epidemic of 1887–88 in Aylesbury, the maximum fatality was observed only after a prevalence of some months of the recognised disease. From April to the 20th of November (nearly eight months) 86 cases and 10 deaths occurred; then, during the next eight days there were 10 deaths, all amongst recent cases. From the 20th November to the end of the year there were 45 cases and 17 fatalities.

Prevalence of "Sore-throat."

The medical gentlemen of Aylesbury favoured me with clinical accounts of the sore-throat spoken of as prevalent. In recognisable features the affection does not appear to differ from that of an erythematous or follicular tonsillitis. The small white or yellowish specks on the swollen and hyperæmic mucous membrane of one or both tonsils, common to that affection, never, it is said, assumed the appearance of the thick continuous membrane of developed diphtheria, and disappeared after one or two days' duration; slight follicular erosions of the tonsils were frequently seen. The lymphatic glands were often enlarged and tender; and for a day or two constitutional disturbance was present. Albuminuria, in the few cases in which it was looked for, was never observed. General

* Of these solitary outbreaks, one of which occurred in August and two in October, I could obtain no satisfactory explanation. In one case, however, the disease had prevailed in the same house 10 months before; in another, the first sufferer had, it was stated, passed through an attack 18 months previously while living elsewhere. In two of the three houses the disease again made its appearance during the progress of the 1887–88 epidemic.

debility of some duration frequently followed these attacks, but distinct paralyses were absent. Children and young adults were attacked in largest proportion, and occasionally, it is said, several members of a family suffered simultaneously, or more often in rapid succession. Dr. Eagles, who tells me he has seen perhaps 200 of these cases, speaks of them as generally multiple, and is convinced of their infectiousness. Dr. Hilliard likewise holds this view.

Dr. Gresswell reported the first case of the epidemic of 1885–86 to have occurred in October in the person of a child (Flory R.), living in Church Row, St. Mary's Square. No evidence of recent exposure to infection was discovered, but it was noted that a servant maid had in the month of February previous returned to her home in the same row after an attack of diphtheria; that the girl suffered from a "relapse," so as to be invalided until June, and that cases of sore-throat occurred in her family subsequently to her return in February. The first recognised case in the epidemic of 1887–88 occurred in this same row of six cottages, two doors from the R's. The sufferer, aged 3½ years, had attended the British Infant School for one week, but from choice simply it is said, not from any ill-health, had discontinued such attendance on March 4th, a full month before her seizure. She was attacked on April the 5th and died on the 11th. A baby-brother, aged nine months, had died on the 30th of March, after 14 days' illness, from what was registered as "difficult dentition, bronchitis;" and at the latter date an elder child was feeling poorly, it was said, although without any complaint of sore-throat. From the history there seemed no sufficient reason to suspect diphtheria in these cases, but whichever was the first attack in this household, no suggestion of recent exposure to infection could be discovered.

Recognised outbreaks of Diphtheria: one of 1885-86,

one of 1887-88.

On April 6th, the day following the little girl's seizure, another girl living in Bicester Road (nearly half a mile from Church Row) who was a pupil at the British Infant School up to the time of her seizure, was attacked. She had not visited at Church Row (situated on the other side of the school from her house), and no evidence of exposure to infection could be obtained. This child died on the 16th. Both these cases were single ones, so far as any recognisable diphtheritic seizure was concerned, or so far as any illness was concerned, except that above mentioned in Church Row.

On April 14th (as nearly as can be said—some trifling sore-throat may have existed a few days earlier), a child living at a place called New Zealand, not far from Bicester Road, sickened. She attended a small dame school in Ripon Street, but was acquainted with the second child referred to above, with whom she may, before that child's confinement to the house, have associated. No other suggestion of exposure to infection could be found. A sister fell ill ten days later.

During the first week of May, two children of a family in Northern Road, Bicester Road, pupils at the British Infant School, were seized, at an interval of five days, with diphtheria; another family at New Zealand (the first sufferer not attending school) was infected, and the wife of the master of the St. Mary's School, in a different part of the town, fell ill. In these cases, again, except in so far as the school may have afforded opportunities for the school children, and except for a remote chance in the case of the lady from a visit to the British School mistress, exposure to danger of infection (and the existence of apparently simple sore-throat as well as of recognised diphtheria was of course searched for) could not be shown.

The order of attacks that, whether from clinical or etiological evidence, are here regarded as diphtheritic, was as follows:—

Table II.

—	Total.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1887.													
Family invasions	79	—	—	—	3	8	8	6	8	6	3	24	13
Cases - -	131	—	—	—	4	12	14	7	13	11	9	32	29
Deaths - -	27	—	—	—	2	—	1	1	4	1	1	10	7
1888.													
Family invasions	12	6	4	1	1								
Cases - -	26	11	7	3	5								
Deaths - -	5	2	2	—	1								

The influence of personal infection; generally.

Of course the existence of hidden sources of infection was always inquired for; still the suspicion that an inconspicuous, and perhaps even unnoticed, disease of the throat may originate true diphtheria makes it extremely difficult to speak with any confidence as to the part that infection from person to person may have played in the epidemic disease. The gradual growth of the epidemic under investigation is strongly indicative of some slowly progressive mischief such as would be supplied by the multiplication of foci of personal infection; and, in a large number of instances, the history of individual seizures supports the view that this has been one of the chief operative causes. Still, allowing for all such cases, and excluding also those in which the first sufferer had within a fortnight attended a school where some earlier sufferer is known to have been received, there remains a notable proportion of initial cases, a proportion equal to 30 per cent. of the total number, as to which no evidence of previous exposure to infection, either from developed diphtheria or from mere "sore-throat," could be obtained. It is somewhat remarkable too, if personal infection were the all-important factor in the disease extension, that its effect should have been so moderate in individual household invasions. Of these, the attacks were single in 52 cases, or 57 per cent. of the total number, and in 23 of the remaining 39, the disease extended to two inmates only of the infected dwelling; an experience the more significant since, as a rule, little precaution as regards isolation, &c., was observed.

The *sequence* of cases in houses where multiple attacks occur affords evidence probably of comparatively little value in an examination of this kind where the disease in question is diphtheria; the incubative and prodromal stage being so very variable and the former often of such short duration. So far as it goes in this case, the evidence is consistent with the view that personal infection was accountable for the occurrence of the great majority of secondary cases. In 16 households a second attack occurred within a week of the first; in only two could there be said to be no appreciable interval between first and second seizures. On the other hand, in several instances the interval was prolonged—from three to ten months in eight cases—so as to constitute what may be called recurring outbreaks. To this point I will again refer.

Importation.

In no case during the last epidemic did I find reason to conclude that the infection had been imported from other districts. On the other hand, there was evidence of its transmission from the town into the Aylesbury Rural District in three instances, and a probability of such transmission in two others.*

* In three cases referred to the circumstances are of some interest. At Weedon a child, aged 5, sickened on October 4th, and died on October the 8th, of whats

The age and sex distribution in the 157 cases that occurred between April 1887 and May 1888 is shown in the subjoined table. Of initial attacks in families, 66 per cent. were amongst children of school age, 4 to 14; of secondary cases, 56 per cent. belonged to that age. Some slight preponderance of the disease was observed upon the female sex.

Table III.

Epidemic, 1887-88.	Sex.	Total.	Under 1.	1-4.	4-8.	8-12.	12-16.	16-25.	25-40.	40-60.
Initial attacks in families.	M.	42	—	4	14	13	4	5	1	1
	F.	49	—	7	19	10	3	3	5	2
Subsequent attacks.	M.	29	1	4	8	6	5	2	2	1
	F.	37	1	7	10	8	4	2	4	1

School children.

The next table shows the incidence of the disease, at different periods of the epidemic, upon children attending different schools and upon non-attendants.

Table IV.

Schools.	No. of Children on Books.	Initial Attacks in Families, 1887-88.										
		Total.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.—April 1888.
British - -	467	20	1	3	1	3	—	—	2	6	2	2
St. John's - -	271	12	—	—	—	1	—	1	—	7	1	2
St. Mary's - -	302	5	—	1	1	—	—	—	—	3	—	—
Walton - -	224	—	—	—	—	—	—	—	—	—	—	—
"Latin" - -	40	1	—	—	—	—	1	—	—	—	—	—
Free - - -	100	2	—	2	—	—	—	—	—	—	—	—
Private Day Schools (six represented).	143	12	1	—	2	1	3	—	—	3	—	2
Total school attendants.	?	52	2	6	4	5	4	1	2	19	3	6
Non-attendants -	?	39	1	2	4	1	4	5	1	5	10	6

Note.—The three schools first mentioned above were closed on November 29th, at the request of the Sanitary Authority, and remained closed until January 1st. The three cases entered against them in December occurred within 4 days of their closure.

These three schools were closed also for the summer holidays from July 29th to August 29th.

stated to have been well-marked diphtheria. She had not been away from the village for some time, but a brother went daily to the British School at Aylesbury. He suffered just before, and at the time of his sister's illness, from a "bad cold," with fœtid nasal discharge, but although confined to the house for a few days, received no medical attention, nor were any paralytic symptoms afterwards observed. Cases of diphtheria had occurred in two neighbouring cottages in March 1886, spreading apparently then from an imported case, but there had been no appearance of the disease in the village during the 18 months' interval. There had, however, been a few well-marked cases of scarlatina (the diagnosis being verified by subsequent desquamation, dropsy, &c.).

At Dinton, a village in which I found sewage nuisances deplorably prevalent, sore-throat of the kind I have described had been general during the close of 1887. In January 1888, what is described as distinct diphtheria appeared in one family, the first sufferer being a young man, whose occupation took him almost daily into Aylesbury. No spread of the disease took place beyond his house; but from the evidence we now possess of the influence, at the least in predisposing a population to epidemic diphtheria, of prevailing "sore-throat," it cannot be doubted that the little village of Dinton had a very narrow escape from a serious disaster.

At Oving, a girl, aged 14, sickened with diphtheria on November the 13th, 1887, and died on the 24th; her brother was seized on that day, and died on the 30th. The medical man in charge of the cases after performing tracheotomy was likewise attacked. No other cases of diphtheria were known of in the neighbourhood. The first sufferer had for some time only been away from home once, and then to a tea party held on the 8th of November in the Corn Exchange, Aylesbury; *i.e.*, five days before definite symptoms of infection were observed.

The facts given in the above table cannot be studied without a strong suspicion that at one period, in the month of November, certain schools became centres of infection. From April to November the evidence would not, I think, justify such suspicion, for although during that time certain schools are seen to have suffered more than others, this was not, on the whole, inconsistent with the explanation that their pupils chanced to be drawn from the more infected localities.* I have shown that in already infected households, where all may be said to be exposed to infection, children of school age, 4 to 14, supplied 56 per cent. of secondary attacks, and this may probably be taken as indicating approximately the normal disposition to infection at such age. From the commencement of the outbreak until November the proportion of school children (attendants) amongst primary sufferers was equal to 55 per cent. of the total number.† During November, of 24 primary attacks, 19 were amongst children attending school. On the 29th of that month certain schools, as mentioned above, were closed, and remained closed throughout December, so that further comparison for that time is, of course, invalidated.

The "explosion" in November.

When the circumstances come to be more closely examined a doubt, however, arises whether this excessive activity of the infection in November resulted simply from opportunity offered by school attendance. If it were only this, it is singular that *three* of the public schools should be simultaneously involved in the greater activity; and then, as to different classes and divisions of the schools, except at St. John's, where the infants suffered in excess, there was no particular incidence of the disease in this more intimate sense. Coincident activity of the infection, although less marked, was noticeable also amongst the pupils of private day schools, and amongst "non-attendants," a little more noticeable than appears from the above table, for just at this time one of those "recrudescences" of the disease, in a family infected some months before, occurred, as well as one other case which, although I have not classed it as a "recrudescence," the interval since the previous attack being short, was probably of that nature; it was now, too, that one of the families in the rural district was infected from the town. The disease, again, exhibited at this period, as I have said elsewhere, extraordinary increase of *fatality*. It is necessary to subdivide the cases further than is done in the preceding table to show how suddenly the infection became active at various points.

It is worthy of remark that the "explosive" force of the 1885–86 epidemic was also manifested in November. The 37 household invasions included in Dr. Gresswell's inquiry were thus distributed:—in October, 5; in November, 15; in December, 11; in January, 4; first half of February, 2.

It is to be noted also that the increased fatality of the disease in November 1887 did not appear to be associated with any particular strain of cases, or with school attendance. Four of the British School children, infected during that month, died; two of the St. John's children; two of the St. Mary's; two of those attending private schools; and (exclusive of the country case) three "non-attendants."

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* Walton, and the immediate neighbourhood of the Walton Schools, remained throughout almost entirely free from the disease. The western side of the town, whence the British Schools derive a large number of pupils, was, on the contrary, early and seriously infected. The Free School is supplied from a wider source, but the two children belonging to that school infected in May both lived in New Street, in the more involved quarter of the town.

† It will be remembered, however, that the elementary schools were closed during August. The comparison, for this and other reasons, is not exact, and possesses only approximate value.

Table V. Daily Record of initial attacks and of deaths during November.

School, &c.	Class.	November.																			Dec.	
		11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	1.	2.
British	Boys (163)	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–
	Girls (168)	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–
	Infants (136)	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	1	–	–	–	–	–
St. John's (no Boys' School).	Girls (120)	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Infants (151)	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2	–	–	–	2	1	–	1
St. Mary's	Boys (113)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
	Girls (73)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Infants (116)	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Private Schools	Collegiate	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
	Miss Cole's	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Miss Wadam's	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Non-attendants	——	–	–	*a*1	–	–	–	1	1	–	1	–	1	–	–	–	–	–	–	–	1	1	1
Total family invasions	30	1	1	1	1	–	–	3	2	–	2	–	1	1	2	4	–	1	1	2	2	3	2
Deaths (amongst November cases).	11	–	–		–	–	–	–	–	–	1	2	1	1	1	1	1	1	1	–	–	1	–

Note.—The returns up to November 29th as to school children give the date of leaving school through illness.
a. Case at Oving infected from town. [The two deaths resulting from this extension to the rural district are not included above.]

A classification of these November cases according to *habitation* gives a result, some idea of which may be gathered from the following statement :—

It would seem that the grouping observed is greater in amount than can be accounted for by influence of school attendance, and somewhat different in kind. The large incidence, however, upon the infants of St. John's school will have been noticed. Within so short a time that a round of personal infection could scarcely have brought it about, various individuals—children at different schools and "non-attendants"—have appeared to become infected in the same localities.

Table VI.

Localities comprising	Families invaded.	School attendance, &c. (respecting initial sufferer).
Cambridge Street, with short cross streets — Eastern Street, St. John's Road, and Mill Street (about 200 houses).	8	6, St. John's School. 1, British ,, 1, Non-attendant.
Walton Street (town end), with Great Western Street, Market Square, and Market Street (about 100 houses).	8	3, Different private schools. 1, St. Mary's. 4, *Non-attendants. [*In one of these, the sufferer (the only one of his family) lived in the suburbs, but attended his place of business daily in Market Square; another was the case at Oving (page 111), in which infection had apparently been contracted during an afternoon and evening spent at the Corn Exchange, Market Square.]
Whitehall Street and Ripon Street (about 50 houses).	3	2, British School. 1, Non-attendant.

App. A. No. 13.

On Diphtheria in Aylesbury; by Mr. Spear.

Localities comprising	Families invaded.	School attendance. &c.
Castle Street (lower end) and Oxford Road (about 60 houses).	3	2, St. Mary's School. 1, British „
New Street and Malden Terrace (about 80 houses).	3	2, British School. 1, St. John's „
Northern Road (23 houses) -	1	British School.* [* Shortly before this child's attack the disease had re-appeared for the second time, after a short interval of apparent freedom from infection, in a neighbouring house in Northern Road.]
Four isolated cases		1, a child attending the British School; 1, St. John's School; 2, Non-attendants.

Summary of evidence as to schools.

Speaking again of the outbreak as a whole, there is marked contrast between the more recent evidence obtainable as to the implication of schools and that recorded as concerning the previous epidemic. Of late no school has played any predominant part in the spread of infection; except for the St. John's Infants' School during November, no one class or division of any one school suffered disproportionally in any very notable degree; throughout the epidemic a considerable proportion of attacks occurred unassociated with school attendance.

A distinction must, however, be drawn between this general evidence and that relating to the particular outburst in November. In the latter half of that month some special danger, it can scarcely be doubted, assailed the children attending the St. John's and the British Schools respectively. Before, however, concluding that this arose simply from the opportunities afforded by school attendance for the spread of the disease by personal infection, the following considerations, it seems to me, have to be borne in mind: The opportunity, arising from the presence of infected children, had existed for some months previously in both schools, and notably in the British School (*vide* Table IV.); the sudden outburst was simultaneous in both schools; the severity of the disease (as shown by the fatality) was co-incidentally largely increased; the greater virulence of the disease at this time (in its spreading and its killing power) was not confined to these schools, although most noticeable there, nor to school children.

It will be noticed that the period of this exaggerated activity, the fourth quarter of the year, is the one in which diphtheria, speaking of the disease generally, is apt to show an epidemic impulse; and that the month was the one in which it became epidemic before in Aylesbury. Suppose then, that this activity is the result of some natural extrinsic condition (meteorological or other) operating upon the contagious principle of the disease so as to increase the danger of infection from person to person, in such case we should expect to see the proportion of secondary attacks in families largely increased at this time. That, however, does not seem to have occurred. The proportion of secondary attacks during November and December was equal to 65 per cent. of invasions, while in the other months of the disease prevalence the corresponding proportion was 77. The only alternative hypothesis, it seems to me, would be one which would contemplate the operation of some extrinsic agent upon a miasmatic, as opposed to a purely contagious, principle in diphtheria infection.

Other possible sources of infection; milk.

No suspicion attaches to the milk supply. In the case of 68 infected families milk was obtained from 15 different purveyors, and nine was

the largest number of infected households supplied by any one of these. In eight families no milk, or only condensed milk, was used. The families infected in November were supplied from 11 different sources.

Water.

No special incidence occurred upon users of different water supplies. The public supply is widely distributed beyond Aylesbury, and 18 of the infected families resorted to private wells.

Diseases of animals.

Swine fever appears to have been the only recent epizootic of the neighbourhood. I found no evidence of connexion between ailments of domestic animals and the epidemic disease.

Locality; grouping of cases.

The disease was widely distributed over the town, so that no considerable locality entirely escaped. The houses in infected streets, &c. (those in which from first to last in this most recent epidemic one or more cases of diphtheria have occurred), number 1,250 of the 1,600 houses, or thereabouts, in the sanitary district. There was, however, some notable grouping of cases, both as to time and as to place. In the lower half of Cambridge Street and the short streets branching therefrom, 17 of the 200 houses were infected; of the 200 houses in Whitehall Street five were invaded, and similar small grouping was observed in the upper or town end of Walton Street, with the adjoining Market Square and Great Western Road; in the lower part of Castle Street, in Ripon Street, New Street, and elsewhere. Except for the short cross streets from Cambridge Street, the places named all belong to the older parts of the town, although the few very old courts and alleys are not represented. In Victoria Park, a modern and outlying locality, there was likewise a grouping of cases, but here was evidence in four initial attacks, of importation from the town. Walton, another outlying locality, escaped in the epidemic of 1885–86, and in 1887–88 only two houses were infected; the disease being apparently introduced into one from the town, and spreading thence to the second, the charwoman and nurse's residence.

Recurrence of the disease in same locality.

The localisation of the disease was exhibited in another way, viz., by its *recurrence* in places that had been infected in the outbreak of 1885–86. (*Vide* appended plan.) Some appreciation of this may likewise be obtained by a comparison, shown below, of the localities in which fatal attacks occurred during the two epidemics. I have bracketed the streets, &c., that stand in juxtaposition.

Table VII.

Streets, &c.	No. of Houses.	Deaths during Epidemics of		Remarks.
		1885–86.	1887–88.	
Church Row	6	1	1	Initial cases in both outbreaks.
Parson's Fee	11	3	2	——
Hog Lane	9	1	—	——
Kingsbury	43	4	—	Non-fatal cases in 1887-88 in two houses, next door to those previously infected.
Cambridge Street	164	8	6	——
Anchor Lane	19	1	—	——
St. John's Street	11	1	—	Non-fatal attacks in house next door in 1887–88.
Eastern Street	8	—	1	Non-fatal attacks in same house in 1885–86.
Dropshort	49	2	—	Non-fatal attacks in house next door in 1887–88.
Whitehall Street	40	2	1	——
Ripon Street	11	1	2	——

Streets, &c.	No. of Houses.	Deaths during Epidemics of		Remarks.
		1885-86.	1887-88.	
New Street - -	55	1	—	Five families infected, 1887–88.
Maldon Terrace -	26	—	1	One family infected, 1885–86. In 1887–88, three deaths, in addition, from croup. Those, and the fatal cases of diphtheria, in houses in immediate proximity.
Fleet Street -	6	1	1	——
Mill Cottages -	18	1	2	——
Northern Road -	23	2	2	——
Bicester Road -	73	—	1	Two families infected in 1885–86.
Southern Road -	1	—	1	——
Buckingham Street -	56	1	—	Three houses infected, 1887–88 (two being previously infected in 1886).
Nag's Head Passage -	8	1	—	——
Market Street -	8	—	1	——
Market Square -	45	—	1	One family infected, 1885–86.
Great Western Street	16	—	1	——
Walton Street -	78	—	3	——
Castle Street - -	46	—	2	——
Oxford Road - -	41	—	1	——
Victoria Park - -	110	—	2	——

In the first epidemic then the streets contributing the total mortality contained 529 houses, or an estimated population of 2,710, so that the death rate was 11·4 per 1,000 of the street population; in the second epidemic the mortality rate was equal to 6·3 per 1,000 of this population, whereas in the remaining streets the corresponding ratio was 2·3. A summary such as this, however, scarcely serves to show the full parity of experience. To appreciate this the mortality of the several streets during the two epidemics (its variations and repetitions), given in the tabular statement above, as well as the notes contained in the last column, must be studied.

I have already discussed the influence that may be attributed to schools in the later distribution of the disease, and have given my reasons for regarding such explanation as incomplete. As to *class*, all descriptions of houses, from the Manor house downwards, have been involved during the two epidemics. The families of four of the members of the Local Board have been attacked, two of them twice, by the disease. The trading classes generally have suffered severely; a private boarding school for the sons of gentlemen was in July 1886 permanently broken up owing to repeated outbreaks of diphtheria. The house, a large one, standing in its own grounds, was in a much infected locality.

Recurrence in the same house.

The next step in evidence as to localisation of the disease would naturally concern its recurrence in individual houses, and then its appearance in houses immediately adjoining those infected during the earlier epidemic. My information on this head is naturally incomplete (the absence of a complete list of cases during the earlier epidemic, combined with the lapse of time, removals, &c., could hardly fail to result in this), but even as it stands it affords some positive testimony.

Nine houses invaded during 1885–86 were again, in the outbreak of 1887–88, the seat of disease. In other words, estimating the number

of infected houses in the first outbreak at 80,* even at this high computation their inmates suffered during the recent epidemic more by 60 per cent. than the rest of the inhabitants of infected streets, or to somewhat more than twice the extent of their fellow townspeople generally.

Again, during the progress of the last epidemic, the disease made its appearance twice, by two apparently separate and distinct invasions, in eight houses; the interval between the first and second ranging from three to 10 months. (In three cases, three to four months; in three, four to five months; in one, six months; and in one, 10 months.) Before the second appearance of the disease the house had in each case been apparently free from infection for some weeks at least.

Appearance (after long interval) in adjoining houses.

In 10 cases the disease was found to have made its appearance next door to houses invaded during 1885–86. In two of these cases, however, the disease had meanwhile re-appeared in the house next door (the one invaded in the earlier year); the interval between the second invasion of the one house and the first of the other being, in the two cases, five days and four months respectively.

In considering the question of the recurrence of the disease in the same households, the possibility of family or individual predisposition has to be borne in mind. I can only say that I found no evidence to justify such an explanation. Except for the fact of recurrence, there was no evidence of greater disposition to spread in families in which two invasions occurred; and, as to *individual* susceptibility, in only one case did the disease start definitely a second time in the person of a previous sufferer.

In the case, again, of second appearances of the disease in a family during the same prevalence, the possibility of the occurrence of chronic attacks with prolonged infectiousness, or of mild inconspicuous attacks bridging the interval, has to be considered. The histories I have obtained lead me to believe that chronic cases, or cases attended by relapse so as to cover a long period of time, and at last perhaps proving fatal, may occur; but in the instances of "recrudescence" I have given, such explanation was, I think, sufficiently excluded. I will give the history of one such instance.

In Northern Road (a small private street of 23 houses, in which five cases of diphtheria and two deaths had occurred in the epidemic of 1885–86) two children of one family fell ill during the first week of May 1887. They were both attending the British School, but only one case of diphtheria, and that a month earlier, had up to that time occurred amongst their school fellows; indeed, these cases in Northern Road are mentioned on page 109 as amongst the earliest. The children recovered, and on June 6th were both attending school again. On September 23rd another child of the family, not attending school, was attacked by diphtheria. I could hear of no exposure to infection since her sisters' illness, nor could I learn on careful inquiry of any other case in this street during the interval of some four months that had elapsed. A fortnight later a young child of another family in the row sickened, and died after five days' illness. The house first invaded was apparently free from infection once more, and the school children were again attending school, when, about November the 8th, the baby, aged 18 months, sickened; another child, aged 4, not attending school, was seized on the 12th and died on the 23rd. A child belonging to another family in the road, a pupil at the British School, fell ill on the 21st of the month. The house where these recurring outbreaks occurred is, it may be remarked, damp, and, owing to drainage defects, exposed to sewage effluvia; the street itself is unmade, sloppy, and neglected.

* Dr. Gresswell gives 37 as the number of infected dwellings from the commencement of the first epidemic to February 21st, 1886, by which time six-tenths of the mortality had occurred; so that it is probable that the above estimate is considerably too high.

Summary (relating to the phenomena of the diphtheria prevalence).

The salient points of this diphtheria prevalence may be stated then as follows :—

1. An epidemic of diphtheria (reported upon by Dr. Gresswell) lasting from October 1885 to the end of March 1886, with slighter prevalence of the disease until July, in a town not before the seat of any such excessive mortality from diphtheria.
2. The first appearance of the disease in this earlier epidemic in a row of cottages into which a stray case of diphtheria had been imported some months before. Its subsequent spread for some time almost exclusively amongst the children of certain day schools.
3. The reappearance of the disease, after nine months' interval of almost entire freedom from recognised attacks, in April 1887. Its continued, but comparatively moderate, prevalence until November; and in that month, as in November 1885, an epidemic outburst.
4. The absence in this later prevalence of any history of importation; the freedom of milk or water or of domestic animals from any suspicion as agents in the dissemination of infection.

   The circumstances of onset, and, later, of epidemic outburst, apparently inconsistent with the theory of personal infection as a sufficient cause; and the difficulty in a large proportion of individual cases of ascribing the spread of the disease to that agency.
5. The first appearance of the disease in the later prevalence in the same row of cottages primarily infected in the earlier epidemic. Subsequently, its marked disposition to reappear in localities previously invaded.
6. The occurrence of sore-throat, of an apparently non-specific kind, preceding, and in a measure accompanying, the recognised diphtheria outbreaks.

Part II.—Sanitary Condition of the Town.

Considered in relation to Diphtheria Prevalence.

Topography.

The town is built on the summit and slopes of a slight eminence, the latter at its highest point some 50 feet above the surrounding Aylesbury Vale. Several rivulets drain the Vale, and on the south and east of the town, two branches of the "Bear Stream" flow just at the foot of the eminence.

Geology.

The geological formation of the district is the Upper Oolite, the summit of the eminence on which the town stands consisting of Portland Stone, and the slopes and land around of Kimmeridge Clay, overlaid by a rich mould. On the south and south-east, where Walton and the new suburban district of Victoria Park are situated, outcrops of Portland Stone again occur. The locality is said to be somewhat subject to fog. Some meteorological data are appended.

Some 700 of the houses of the district are situated upon the rock, the remainder (some 900) upon clay. Of the former, during the last epidemic, $4\frac{1}{2}$ per cent. were infected; of the latter $6\frac{1}{2}$ per cent. In the previous epidemic somewhat similar incidence was observed.

Streets and roads.

The central parts of the town are, as described by Dr. Gresswell, irregularly and closely built; with narrow roughly paved streets, and with a market square the source of much complaint by the residents of the immediate neighbourhood owing to its defective paving and surface drainage. The numerous private streets and roads of the less central localities remain with few exceptions (the exceptions being Ardenham

Street, West Street, and Mount Pleasant, which have recently been sewered, metalled, paved, and channelled at a cost of 650*l.*) in much the same condition as Dr. Gresswell described, "commonly not levelled "or drained, and in wet weather covered with clay mud to the depth "in some instances of half a foot." Northern Road and several of the cross streets from Cambridge Street, all of which were involved in the diphtheria outbreak, afford notable instances of this state of things.

House accommodation.

In certain of the older and more crowded courts several of the cottages have fallen out of occupation since Dr. Gresswell's visit. A number, however, of the same class remain; although, owing to dampness, dilapidation, want of proper ventilation, and from unwholesome surroundings, they are unfit for habitation. Crown Court, Queen's Court, Bull's Head Square, in the central quarter, may be particularly mentioned; as well as small blocks and single dwellings (Frances Place, cottages in Whitehall Street, &c.) in various parts of the town. Other old cottages, although clean and less generally unwholesome, are seriously deficient as regards ventilatiou and air space (of these, examples may be seen in Friarage Road, Chapel Row, &c.). In the more modern cottage property, the absence in the past of proper building regulations is conspicuous. Proper elevation above the ground level, ventilation beneath the boards, the use of damp-proof courses, are, especially, requirements frequently lost sight of. Even now, with building byelaws, and a capable and energetic but overworked officer for their enforcement, it is found apparently extremely difficult to secure in building operations due regard to sanitary requirements. The Surveyor needs in this, as in other matters, more personal assistance, as well as all the moral support that the Authority can afford him.

Excrement disposal.

With a few exceptions in which privy pits are in use, excrement disposal is by pan closets connected with the sewers. In cottage property, flushing apparatus is scarcely ever provided; and as the drains in addition are generally of the most primitive kind, nuisances from choked and overflowing closet pans are of frequent occurrence.

Scavenging.

The removal of house refuse is more efficiently carried out than at the time of Dr. Gresswell's inspection. Victoria Park and a few isolated places only afforded cause for complaint on this head.

Water supply.

The mains of the Chiltern Hills Water Company are available in the town, and some four-fifths of the population obtain a supply from this source. The water is from deep wells and extensive adits in the chalk, one of the wells being situated at the summit of the Aston Clinton Hills, the other, newly sunk, near Tring. The water is of the usual pure quality of waters so derived, and is softened by Clarke's process before distribution. The service is on the constant system, but during last summer, as in the summer of 1885, an intermittent service had to be resorted to.

The remainder of the population obtain their supply from numerous local wells. Many of these are open to grave suspicion of contamination, and it should be the policy of the Authority to secure their disuse. No suspicion, however, attaches to them in connexion with the diphtheria outbreak.

Condition of the schools.

At the time of Dr. Gresswell's inquiry, the public elementary schools were found to be open to serious sanitary objection; on the ground, firstly, of inadequate room ventilation, and, secondly, on account of defective drainage and closet arrangements. The ventilation has, in most instances, been considerably improved by the introduction of what are known as Tobin's tubes, as to which, however, it appears to be forgotten that cleansing is required. In the matter of drainage the alterations effected cannot be spoken of as adequate. At the British

Girl and Infants' School flushing apparatus has been attached to the closets, and some ventilation by pipe shaft has been provided in the drains. The closets, however, are still practically within the school buildings, and the infants' schoolroom, especially, is not sufficiently removed from danger of air contamination from this source ; the danger being the more serious from the extremely defective and foul condition of the public sewer or culvert into which the closets discharge. At the St. John's and the St. Mary's Schools, a daily flushing of the closets by hand is still relied upon. The condition of the playgrounds requires attention for the avoidance of undue exposure of the children to wet.

Sewerage and drainage.

To the subject of sewerage and drainage of the town special attention needs to be directed. Some 10 years ago a scheme for its complete sewering was devised by Mr. Hawksley ; but, although a sum of 25,000*l.* is said to have been spent, little more than the outfall and purification works (in themselves very complete), together with the necessary intercepting sewers, were constructed. The law was complied with, and so much of the sewerage as was discharged at the end of the sewer system was purified, but the old tributary sewers were left all over the town ; and the latter could have derived, so far as health is concerned, exceedingly little benefit. Except for the occasional construction of a new sewer in place of an old one, matters have remained in this position ever since, and even when a new sewer has been constructed many houses that might have drained into it have remained connected with the ancient culvert. These culverts, containing sewage matters excessively foul from long retention, have, moreover, been allowed to ventilate themselves through the new sewer gratings, and to discharge their contents into the new sewers ; with the result that the latter have themselves become excessively foul, and their ventilators so intolerable a nuisance that in the greater number of cases the people in the vicinity have insisted upon their closure.

Of these old culverts, there are, it is estimated, some five thousand yards in the town. They are built of loose brickwork, allowing percolation to take place freely into the soil, and those that I saw opened contained a large amount of thick black sludge. They lie generally shallow beneath the surface, and are occasionally beneath the kerbstone, so as to be quite close to the foundations of houses. Of many of them, however, no information whatever is obtainable, and from a not inconsiderable number of houses all excrement and slops (for it is to be remembered that this is now a "water-closet town") go no man knows where.

Private drainage is in large measure equally defective. Often constructed of brick or of "butt-jointed" pipes the drains not unfrequently pass beneath houses, so that the foundations of many houses must be impregnated with sewage effluvia. Unbroken drain connexion between the dwelling and the sewer is not uncommon.

I have shown that diphtheria, as defined in this report, has in its prevalence exhibited a notable and hitherto unexplained tendency to localisation. The corresponding facts as to the sore-throats, regarded as not being of diphtheritic nature, are not here recorded. Detailed examination of the circumstances shows these localisations to have been in almost every case associated with grave defects of sewers or drains ; defects which have led to the contamination of the atmosphere in and about houses with sewage effluvia, and to sewage contamination of the foundations of houses. I will describe the conditions observed in a few typical cases.

The first case of diphtheria in each of the two epidemics occurred, without demonstrated exposure to recent risk of infection, in houses of one short row next door but one to each other. Some trifling alteration

was made in the drainage after the first outbreak, and, after the second, owing to continued complaints of nuisance and of the entrance of rats into the houses (the latter a very frequent cause of complaint in Aylesbury), the common drain of these cottages was uncovered. It was a drain receiving the discharge of closet pans as well as slop water; it was carried beneath the floors of the kitchens, and it was constructed throughout its whole length of perforated bricks, so as to facilitate soakage from it.

A notable group of cases occurred just at the top of Walton Street, Market Square, and Great Western Street. Ten houses were invaded, three of them twice at long intervals, and the occupier of an office in Market Square was also attacked. The three houses invaded at the top of Walton Street were said to drain to a new pipe sewer, but on examination the drains of two of them were found to discharge into an old, open-jointed brick and flag culvert. It contained extremely foul deposit some inches in depth, and passed just beneath the flags of the footway close to the foundations of the houses. With this old culvert, moreover, the Market Place sewers (one old and one new) and the Great Western sewer were connected. Naturally under the circumstances they were excessively foul, and most of their ventilators had been stopped up accordingly. In addition to this, the private drainage arrangements of nearly all the houses invaded were such that the air of the sewer would under the circumstances inevitably penetrate to the interior of them.

The sewer of Cambridge Street is a 15-inch brick culvert; the invert not jointed, and the bricks "laid dry." In a length of 400 yards it contains no ventilator. It was found to contain about two inches in depth of black deposit. The inhabitants complain generally of escape of foul air from gullies, private drains, &c., and this was so notably at one point, near Frances Place, around which a grouping of cases of diphtheria had occurred. The private drains of this street are generally old, and of similar defective construction (unventilated and leaky); they were found to be carried beneath several of the infected houses; in three of the latter "internal connexions" were observed.

The condition and construction of the sewer of Ripon Street and Whitehall Street, and the private drainage there, are, in essential respects, precisely similar. There also, amongst the group of infected houses, the escape of sewer air by private drains, &c., was complained of.

The Castle Street sewer, of similar construction, was opened for my inspection and found to be nearly choked with foul deposit. Three children of different families, living at or near the lower end of this street, died in November of diphtheria. They were known to have played together about an untrapped gully communicating with this sewer, at a place before complained of as horribly offensive from sewage effluvia. A child living in a house higher up the street had, in the previous June, suffered from diphtheria, and the same sewer had had opportunities of specific infection during the epidemic of 1885–86 from its higher ramifications.

The sewer into which the British Schools are drained was likewise opened for inspection. It was found to be of the same construction and half full of black deposit.

In a house in Mill Street, Cambridge Street, a woman, aged about 50, suffered from an attack of diphtheria in November. Her husband was infected about three weeks later, but the other members of the family, grown up sons, escaped. The circumstances were such that exposure to direct infection appeared to be most improbable; but it was found that the woman was accustomed to work in a cellar kitchen, having direct communication with the sewer, and much invaded by sewer air. A

woman living at Parson's Fee, who suffered from a fatal attack, was, it seemed probable, infected under similar circumstances in a house in Great Western Street—a street the sewerage of which has already been described.

In St. John's Road, Cambridge Street, three children of a family (one of them aged nine months) sickened of the disease within a day or two of each other. The drainage had been before the subject of complaint, and now, on examination, an open-jointed pipe drain was found to be carried through the house just beneath the flooring. Sewage matter had been escaping at all the open joints, and the foundations were spoken of as "gutted" with sewage.

It is unnecessary for me to continue the relation of such cases. They might, if need be, be multiplied, but of themselves they afford a fair indication of the circumstances under which a large proportion of recent sufferers from diphtheria in Aylesbury were found to have been living.

It is admissible now to complete the summary given at the end of Part I. of the Report, as follows:—

7. Endemic prevalence of diphtheria in Aylesbury co-exists with a condition of sewers and drains that is productive of excessive filth contamination of soil and air.

Sanitary Administration.

Administration of the Authority.

The Report of Dr. Gresswell, after the inquiry of 1886, dealt largely with the need for improvement in the sanitary administration of the district, and referred specially to the following circumstances as injurious to the public health:—The continued occupation of houses unfit for habitation; the accumulation of house refuse about dwellings; the defective construction and inadequate ventilation and flushing of many of the public sewers and private drains; the want of proper surface paving and channelling of many streets and courts; the nuisances arising from the proximity to dwellings of ill-kept slaughter-houses. In regard to the means available for checking the spread of infectious disease, the report further stated that notification of such disease to the Medical Officer of Health was entirely without system; that hospital accommodation for the isolation of infectious cases was of a merely provisional character and unsatisfactory; and that no public disinfecting apparatus or public mortuary existed. Copies of this report were sent to the Local Authority, together with the recommendations of the Board thereupon. I have already noted all the action upon this matter with which the Authority is to be credited. The scavenging of the district, although not yet wholly satisfactory, has been improved; some half dozen private streets and courts, at most, have been paved and channelled; here and there some little local improvement has been effected in some particularly defective sewer or drain. In all other respects the sanitary circumstances of the district (the actual condition of premises as well as the means of defence against spreading disease) remain the same as when epidemic diphtheria invaded the town in 1885; with, probably, this important difference, that whereas before that date the half-blocked sewers and sewage-sodden soil were for the most part a source of insidious mischief to general health only, there exists now a probability that they have become the breeding-ground of a specific contagion capable of rapidly destroying human life.

AYLESBURY.

DIPHTHERIA.

- Green Dots mark infected houses (so far as known) Epidemic 1885-86.
- Blue Crosses mark infected houses: Epidemic 1887-88.
- " Lines Inside (or concave side) Rock; outside, Clay
- Brown Lines Modern (mostly pipe) sewers. Filter Tank
- Dots Old sewers of defective construction

Buildings are not drawn to scale.



No. 14.

Report on Epidemic Diphtheria in the Enfield Urban Sanitary District; by Dr. Bruce Low.

The Enfield Urban Sanitary District, with an area of 12,653 acres, and a population at the census of 1881 of 19,104 (now estimated at 23,000), extends eight miles from east to west and three miles from north to south. It has 60 miles of roads, 18 miles of sewers, and 18 miles of water mains. The district was inspected in 1880 by Dr. Parsons, from whose account of it free quotations are now made in reference to certain physical circumstances that are necessary to be borne in mind in what follows respecting the recent outbreak of diphtheria.

Topography.

The district is divisible into three parts, Western, Central, and Eastern Enfield, each separated from the other by more or less open country.

Western Enfield is chiefly rural, and though least populous of the three divisions, contains half the acreage of the whole district. It is situated on the London clay, capped on the hills by patches of glacial gravel and boulder clay. This division is mainly agricultural or pastoral; some of it consists of woodland. It contains no aggregation of population that can be termed a village, except Hadley, which is the only place in it provided with any system of public sewerage or water supply.

Central Enfield comprises the old town of that name with some outlying hamlets, Clay Hill and Forty Hill for instance, and certain important suburbs, Bush Hill Park to the south and Bycullah Park to the west of Enfield proper. Its population is partly industrial and partly well-to-do; persons of the latter class being much more numerous than in the other divisions, and inhabiting for the most part the suburbs referred to. The geological formation of this division is partly London clay and partly the overlying gravels. The water supply of Central Enfield is largely from the high level reservoir of the Local Board's system, but the two suburbs above referred to have each of them separate and independent supplies. All but the outlying parts are sewered, the sewage being delivered by gravitation to the Ponders End farm of the Sanitary Authority. The New River flows through this division.

Eastern Enfield is more populous than the other two parts of the district put together, and its population is mainly an industrial one. Roughly speaking, it has three centres of population, separated from each other by fields and market gardens, viz., Enfield Lock, where is situated the Government Small Arms Factory; Enfield Highway, which

is a long and somewhat straggling village with streets running at right angles from the main thoroughfare; and Ponders End, where there is a considerable industrial population grouped round some private factories. The subsoil of this division is river gravel, with patches of brick earth in places. Its water supply is also from the Local Board's mains, but the water is separately delivered from a low level reservoir. This division, too, is drained throughout, by a low level system separate from that serving Central Enfield, but, like it, discharging upon the farm at Ponders End.

The immediate occasion of this inquiry at Enfield was a greatly enhanced mortality from diphtheria in the last quarter of 1887, as shown by the Registrar-General's returns, and by local representations as to a widespread and fatal prevalence of the malady. The inquiry was begun on February 6th, and much time has been devoted to it.

Diphtheria.

Diphtheria has for a long time maintained itself in Enfield. Since 1873 scarcely a year has passed without deaths from diphtheria being registered in one or another portion of the district. During the last three years the number of such deaths has increased, and this increase of fatal diphtheria has been coincident with a general prevalence of diphtheria over a wide area of country north of London. During 1886 in the Enfield district 24 deaths from diphtheria, and four others from "Croup" were registered. They occurred mainly in Central and Eastern Enfield. Of a total of 14 deaths from this disease in the last quarter of that year, eight were in the Central and six in the Eastern division. At this time there was considerable localisation of mild cases of diphtheria and numerous cases of sorethroat in the latter division at Ponders End. About the middle of January 1887 a single death from diphtheria was also registered at Ponders End, and a few days later another at Enfield Highway. On the 1st of March a solitary death from this disease took place at an isolated locality in the Western division. No further deaths from diphtheria were registered till July, when three occurred in one house in Melville Road, a poor locality in the Central division. The next four deaths were in the Eastern division, viz., one in July, one in August, and two in September. Up to this date, therefore, in 1887, diphtheria had shown no special preference for one over another of the divisions of Enfield. But towards the end of September it began to be epidemic, especially in Central Enfield; of 17 cases coming under notice during this month no less than 12 were in this division, which does not contain half the population of the total district. In October 52 fresh cases were reported, 47 of them in Central Enfield. This rapid development of the malady seemed to begin in Anderson's Yard, which, with neighbouring Gordon Lane and Baker Street, remained for some time the locality chiefly affected. The attacks were mainly among the poorer class; especially did the disease fall upon the children attending the infants' school in Gordon Lane. The average attendance here was 110, of whom 28 had diphtheria in the course of a few weeks, 11 of them dying of the disease. As a consequence there was a panic among parents, and the attendance at this school fell off one half. During November the number of cases seems to have greatly diminished, only 24 being reported. By this time, however, the disease had extended somewhat into Lower Gordon Road, and thence to Chase Side. Here, again, the houses invaded were almost exclusively of the artisan class. But at the end of November and at the beginning of December there was a sudden increase in the number of diphtheria cases, and for the first time the persons affected belonged, and almost

wholly, to the better class. Of 68 cases ascertained to have occurred during December 65 were in Central Enfield, and only three in the remainder of the district. In this outbreak Bush Hill Park especially suffered severely. This suburb is situated partly in Enfield and partly (but to a limited extent) in Edmonton. For the purposes of this report the whole of Bush Hill Park suburb is included with Enfield. Bycullah Park, the other Central Enfield suburb, and occupied also by better class people, suffered at this time similarly, but to a less amount. In January the number of cases ascertained to have occurred was 52, 44 being in Central Enfield, and only eight in other parts of the district. But the incidence of the disease was very different to that of December; the brunt of the malady now falling on the locality near the St. Michael Schools, where it affected specially the school children, and with the result of closing the schools. Coincidently, with the exception of a few cases occurring in houses already invaded, diphtheria practically ceased to attack the well-to-do classes. During February, notwithstanding the number of houses that had by this time become infected, and despite multiplication of opportunities for spreading the disease, diphtheria considerably diminished in the district. Such as occurred, however, was almost wholly among the industrial population.

The following table shows the incidence of the disease during five months, September to January inclusive, on each of the three divisions of Enfield. In the numbers given there are, no doubt, included some cases of non-specific sorethroat which in time of panic were classed as diphtheria. But on the other hand the table almost of necessity excludes not a few minor cases of diphtheria occurring at times when public attention was less exercised by the disease, and which therefore failed to get recorded.

Cases and Deaths from Diphtheria in Enfield District.

Divisions.	1887.								1888.		Total in Five Months.	
	September.		October.		November.		December.		January.			
	Cases reported.	Afterwards fatal.	Cases reported.	Afterwards fatal.	Cases reported.	Afterwards fatal.	Cases reported.	Afterwards fatal.	Cases reported.	Afterwards fatal.	Cases reported.	Afterwards fatal.
Western -	—	—	—	—	—	—	1	1	—	—	1	1
Central -	12	2	47	8	15	4	65	15	44	9	183	38
Eastern -	5	1	5	2	9	4	2	1	8	1	29	9
Totals -	17	3	52	10	24	8	68	17	52	10	213	48

Having regard to the circumstance that antecedent to its extension last autumn, diphtheria had persisted for several years in Enfield and its neighbourhood, inquiry as to origin of the disease was found to be futile. Similarly the lapse of time since commencement of epidemicity of the diphtheria has been a serious obstacle in getting exact information about it. And so it has come about that this report does little more than review the chief conditions, so far as they could be learned, under which epidemic diffusion of the disease has occurred. In what follows, therefore, chief consideration will be given to behaviour of diphtheria in Central Enfield.

In this connexion, and with a view of setting aside conditions not concerned, or only very subordinately concerned, in the epidemic, there will be convenience in passing in review certain locally suggested explanations of the diphtheria, before dealing in greater detail with other conditions which, as will appear, have in all probability been mainly instrumental in the wholesale dissemination of diphtheria that has been witnessed.

About the end of December, when well-to-do houses had become invaded by diphtheria, something like a panic occurred in Enfield, and causes for the epidemic were freely discussed in the local papers, various theories being indulged in. The majority of contributors to the discussion, while blaming the Local Board for neglect of duty, fixed on the sewers or on the water supply as sources of the mischief. Others accused sludge dredged from a portion of the New River and left to dry on its banks, or were confident that manure heaps in market gardens had to do with the illness. On the other hand, in opposition to the Medical Officer of Health, people were disposed to ridicule a theory of contaminated milk, and few appear to have agreed with him in suspecting elementary schools as having had large concern in spread of the diphtheria. Upon the whole, a "sewer gas" theory had locally most acceptance.

As to sewer emanations.—Belief in sewer emanations as a cause of the diphtheria seems largely to have arisen from the circumstance that in Enfield sewer ventilators had, both before and after the commencement of the epidemic, been emitting foul smells. How far these smells were due to constructive defects of sewers allowing deposit in them of sewage sediment, or to imperfect flushing or inadequate ventilation of sewers, cannot accurately be estimated, though there is reason for suspecting that the latter conditions were mainly at fault. But for present purposes exact determination of this matter is of no great moment, since it is extremely doubtful whether sewer emanations, whatever may have been their influence aforetime on the persistence of diphtheria in the distsict, had any real concern with epidemic extension of the disease. As matter of fact, objectionable sewer emanations were complained of over a very wide area, whereas epidemic diphtheria was restricted to certain definable limits. But perhaps more important as bearing on this question is the circumstance that the first outburst of the disease, in September and October, was not in localities such as Bush Hill Park, whence chief complaint of foul emanations from sewers has come, but in another part of the district, which has not been, so far as can be learned, specially troubled in this fashion. The neighbourhood of Anderson's Yard, Gordon Lane, and Baker Street, is the locality in question. Hereon, in September and October, and some time after the street ventilators had been purposely closed by various contrivances, the diphtheria fastened with peculiar severity; not indeed affecting better class houses, which from their more intimate and manifold connexions with the sewers thus sealed inconsiderately might be thought of as peculiarly exposed to danger, but invading dwellings of labourers and artisans, few of which had within them any drain or sewer communications. They were for the most part houses provided with outdoor waterclosets, and unprovided with indoor sinks. Again, as regards the diphtheria outburst of December in the Bycullah and Bush Hill suburbs, whence chief complaints of sewer emanations had been coming, it did not appear on detailed inquiry that there was any particular connexion between the two sets of circumstances. Here, again, though sewer smells had existed for a considerable time and over a considerable area, the diphtheria was greatly limited in time and in area; and upon

a theory of its causation by sewer air an excessive disproportion of escapes to attacks had to be accounted for. But the consideration that would appear to weigh most strongly against the sewer-smell hypothesis is that as regards Bush Hill Park, a notable and simultaneous specific infection of two entirely distinct and separate sewer systems must have existed in order to account for the conspicuous incidence of the disease alike upon that part of the suburb drained by Enfield and on the other part drained by the Edmonton sewers. As regards emanations of other sort, as, for instance, from river dredgings, or from manure, whether spread abroad (in the form of dead dogs from Battersea) or stored in heaps on market gardens, very similar difficulties presented themselves, forbidding easy acceptance of such explanation of the diphtheria. Foul smells having either origin had been strictly local, whereas diphtheria had been widely, if sparsely, distributed; and in so far as diphtheria was localised in its epidemic manifestations the areas affected by it in no instance coincided with areas in which emanations from river dredgings or from manuring processes had been emitted most profusely or for the longest periods. Furthermore, there was the difficulty, as in the case of sewer smells, that persons and families most freely exposed to such emanations for a long while suffered little, if at all, whereas other persons and families far removed from such influences suffered early and heavily from diphtheria.

As to water supply.—Accusation of the Sanitary Authority's water service appears to have been based on very slender data, somewhat as follows:—The water service is distributed over a wide area, as in the course of years had been diphtheria; it is an intermittent service, and at times, as for instance, not long before the commencement of the epidemic, the supply had been manifestly inadequate, and occasionally had been found turbid. No other grounds have been found for the surmise that the water service might have been in some occult way concerned in the diphtheria. The Central and Eastern divisions of Enfield which suffered, as has been seen, very differently from diphtheria, got their public water supply from one and the same well, and no suggestion of contamination of sections of the water service was brought forward. No account appears to have been taken of the circumstance that Bush Hill and Bycullah Park suburbs, simultaneously invaded by diphtheria in December, were supplied with water not from the Local Board's waterworks, but by services separate and distinct from it *and from each other*. No doubt it may be possible, if water ever does serve as a carrier of diphtheria, that three separate water services derived from different and distant sources, may have become at one and the same time carriers of the infection; but the possibility is too remote for useful consideration here.

In passing to consideration of school attendance and of milk service in their relations with epidemic diphtheria, it deserves notice that these agencies were, in the opinion of the Medical Officer of Health, intimately concerned in diffusion of the disease. How far he was justified in his conclusions will now appear.

School Influence.

As will be remembered, the epidemic outburst of diphtheria in Central Enfield, at the end of September and during October, fell with special severity on the locality about Gordon Lane. More exact inquiry about that outburst has shown that it was comprised in the four weeks beginning 21st September, and that during this period diphtheria invaded in Central Enfield 13 separate families, wherein were some

75 individuals, of whom 33 (44 per cent.) were attacked, and no less than 11 died of the disease. Further, it appeared that this outburst, besides being limited in time, was also limited as regards locality. Thus of the 13 families invaded in the four weeks in question, no less than 10 resided within one-third of a mile from Gordon Lane; and of the 39 attacks above referred to, no less than 29 occurred among the 59 members of the 10 families, as did also every one of the 11 deaths from the malady in the period. Detailed inquiry in the neighbourhood in question failed to find, in the sanitary circumstances of the houses, any satisfactory explanation of the outbreak. The houses invaded, as regards their inhabitants, their water supply, their sewerage and drainage, their soil and their surroundings, did not differ materially from hundreds of houses hereabouts. But in one particular they did differ from most other houses, namely, as regards the school attendance of certain of their inmates. Nine of the 10 houses invaded sent children to the Gordon Lane Infant School, and in no less than eight out of the nine, the first person to be attacked in the family by diphtheria was a child attending this particular school. There can hardly be question that this Gordon Lane Infant School played a considerable part, at this time, in disseminating diphtheria. The fact was indeed so far recognised locally that (after about one-fifth of the families sending children to this school had become invaded) the daily attendance at it, owing to presence of diphtheria in families, fell from 110 to 56. By this time, epidemic diphtheria had become fully established in Enfield, and the several families invaded through this school and in other ways, no doubt contributed, by their communication with other people, to maintenance of the disease in the district. The Medical Officer of Health, it should be stated, advised the exclusion of scholars having any sorethroat, or coming from houses known to be infected; but at no time was it judged necessary to close this Gordon Lane School.

Neither during November, in which month diphtheria diminished greatly in Enfield, nor in December, when there occurred a second sudden outburst of the disease, did any one school exercise, so far as could be learned, any special influence in disseminating diphtheria. But during January 1888 there was once more indication that a particular school was giving effect to a fresh epidemic tendency of the disease. The implicated school was this time St. Michael's.*

This school is situated some distance from Gordon Lane and still further from the locality of chief epidemicity of diphtheria in December. As before, the evidence as to influence of school was circumstantial. Among several hundred houses having like conditions of population and sanitary and other circumstances, diphtheria tended to pick out (so far as fatal diphtheria was concerned it did so without exception) families which sent children to the schools in question. Thus of 20 families in Central Enfield invaded during the first three weeks of this year, at least 14 got their diphtheria in the persons of children attending St. Michael's Schools. Here again the fact of school influence became locally recognised, this time by the authorities, and with the result that these schools were closed on January 19th.

Influence of Milk Service.

Early in December, as has been said, diphtheria, which for some weeks had been diminishing, increased again in Central Enfield, and by

* There are in reality three schools of that name, a girls', a boys', and an infants', but as the same families mostly send children to them all, the schools are treated as one.

the middle of the month was once more fatally epidemic. In this second outburst, the chief incidence of the diphtheria was, as already noted, for the first time on persons of the well-to-do class, a circumstance which perhaps had much to do with the demand which now arose for Government inquiry. The better class families thus suddenly, almost simultaneously, and fatally invaded, resided for the most part in the two separate quarters of Enfield, represented by Bycullah and Bush Hill Parks, and it was soon seen that the suburbs in question had not in common those physical conditions popularly believed to be concerned in diphtheria diffusion. They possess water supplies separate one from the other, and distinct also from the public supply of Enfield town. Both, it is true, are, like the town, on the central sewer system, but they are on separate sections of it, and indeed are situated on opposite sides of the town. And farther, Bush Hill Park suburb is drained partly to Enfield and partly to Edmonton sewers. Emanations therefore from one and another sewer section, or from particular manure heaps, or other strictly local collections of refuse, could with difficulty be thought of as having simultaneously affected these separate localities. So, too, with schools and with other places of resort common to the people of both localities, no coincidence of their general use with this sudden extension of the diphtheria was observable. When, however, the incidence of the disease was examined according to the milk services of the several families invaded, there did appear to be some noticeable coincidence; for inquiry at once revealed the fact that every one of the fatal cases in Central Enfield, whose attack commenced at the end of November or during the first three weeks of December, had partaken of milk derived from one and the same source. More detailed investigation in the direction above indicated, made for the purpose of the present report, has afforded the following facts:—It is found that in the period referred to (end of November to 21st of December) 26 families became invaded in Central Enfield, and that of these, 21 (87·0 per cent.) had been obtaining their milk from the source in question. Similarly, of 51 cases reported, over 80 per cent. had been taking this milk, as also had every one of the cases which proved fatal. So far as it went, this evidence lent support to a theory of milk causation of the December outbreak of diphtheria; but inasmuch as it took no account of numbers exposed and *not* exposed to the particular milk influence it was by no means conclusive. Attempt was therefore made at distinguishing families and persons in this respect. To this end, Bycullah and Bush Hill Parks, the localities chiefly affected, along with intervening Enfield town which suffered to a less extent, were roughly divided into two areas:—Area No. I., Bycullah Park with Enfield, N.W., and area No. II., Bush Hill Park with Enfield, S.E. The population of these areas cannot be exactly stated; but for present purposes it will be sufficiently near the mark to regard each area as having about 450 houses, and each house as having an average of six inmates. It was ascertained that in area No. I. $\frac{57}{450}$ and in area No. II. $\frac{153}{450}$ houses had been getting their milk from the suspected source.

Upon these areas, during the December period in question, the incidence of diphtheria on families and persons consuming the particular milk, and on families and persons *not consuming* it, was found to have been that indicated in the following table:

DIPHTHERIA INCIDENCE in CENTRAL ENFIELD during period end of November to 21st December 1887.

Areas.	Houses invaded.		Persons attacked.		Diphtheria Deaths.	
	Taking the particular Milk.	Not taking it.	Consuming particular Milk.	Not consuming it.	Consuming particular Milk.	Not consuming it.
No. I. - -	$\frac{8}{57}$=14 p.c.	$\frac{2}{393}$=0·5 p.c.	$\frac{11}{342}$=3·2 p.c.	$\frac{4}{2358}$=0·17 p.c.	$\frac{3}{11}$=27·2 p.c.	$\frac{0}{4}$=0·0 p.c.
No. II. -	$\frac{13}{153}$=8·5 p.c.	$\frac{3}{297}$=1·0 p.c.	$\frac{31}{918}$=3·3 p.c.	$\frac{5}{1782}$=0·38 p.c.	$\frac{9}{31}$=29·0 p.c.	$\frac{0}{5}$=0·0 p.c.

The complete indifference to locality here shown by the diphtheria as regards its exceptional incidence on consumers of the particular milk, and its fatality to such persons when attacked, accord with previous experience of milk diphtheria, and it is entirely corroborative of the Medical Officer of Health's belief that the milk in question had principal concern in the December outburst of the disease. A very special relation between this milk and the December diphtheria may indeed be regarded as proved, and if the inquiry could have been pursued to the end, it would have remained to discover the reason for the relative immunity from diphtheria of a very large proportion of the customers of the implicated milk service, and the reason for the occasional invasion at this time of houses into which the milk was not received. But the conditions of actual milk distribution, and the distance of time between the events and their investigation, presented difficulties to further investigations, and these have been found insurmountable. Still much time has been spent over inquiry in these directions, and such notes as have been made will remain available for future use in the investigation of milk-diphtheria by the Medical Department.

OTHER INFLUENCES FOSTERING DIPHTHERIA AT ENFIELD.

Besides elementary schools and a particular milk service—agencies which would seem to have been paramount in spreading epidemic diphtheria,—certain other influences were noted during the inquiry as having had concern in the extension of the disease, and some of them deserve notice.

Customs and practices of the working class as helping spread of Diphtheria.—Not a few instances came to light in which parents, accompanied often by children, had visited at houses where diphtheria existed, for the purposes of condolence, of gossip, or of idle curiosity. And very commonly children regarded by their parents as practically well after diphtheria were sent to school without trouble on the part of anyone to obtain certification as to the freedom from infection. So, too, as regards what appear to have been mild cases of diphtheria, people have been content to take advice from "chemists," who in turn have given medicine for "colds," "teething," and the like, with the result that in several instances children having decided diphtheria have mingled freely with their fellows.

Again there is a custom among the working classes in Enfield, as indeed elsewhere also, of assembling children of the family in the sick room to take their last leave of a relative, dead or dying from infectious

disease; and children have even been brought from other districts to take part in such formal leavetaking. Examples of this are given below:—

In one case, a child having been attacked by diphtheria, the rest of the children were sent off to the house of a relation to be out of danger's way. But the case being likely to prove fatal, the children were roused from their sleep at midnight to return to the infected house to bid the little sufferer a last farewell. One little child was brought in a blanket to save time. As the patient was dead on their arrival, they were each lifted up to kiss the lips of their dead brother. Whether from kissing the corpse, or from returning to the infected atmosphere of the sick room, the other children contracted the disease, as might have been expected.—In another instance, a mother kept her little girl, an only child, from school to prevent her catching diphtheria, but she permitted her to go to the house of two companions, who were known to have had throat illness, to play with them during their convalescence. She took diphtheria and died.—In several cases mothers persisted, in spite of the warnings and entreaties of their medical advisers, in kissing their children's lips, and in this way appeared to have contracted diphtheria.

Possible agency of domestic animals in spreading Diphtheria.—During the continuance of the epidemic in Enfield, cats were observed to suffer in considerable numbers from illness; and in December 1887 and January 1888 there was a large mortality among those animals, so much so that the attention of the dust contractor was directed to it. He stated that never in his previous experience had he seen so many dead cats in the dust heaps. Some households seeing their cats ill destroyed them. Though there were no known cases of diphtheria occurring in the practice of the veterinary surgeons at Enfield, yet they saw many cases of "influenza" at this time among animals.

The following is an illustration of the possible connexion between diphtheria in children and in cats:—

A little boy was taken ill with what turned out ultimately to be fatal diphtheria. On the first day of his illness he was sick, and the cat which was in the room at the time, licked the vomit off the floor. In a few days (the child meanwhile having died) the animal was noticed to be ill, and her sufferings being so severe and so similar to those of the dead boy, the owner destroyed her. During the early part of its illness this cat had been let out at nights in the backyard as usual. A few days later the cat of a neighbour who lived a few doors further off was noticed to be ill. It had also been out in the backyards at night. This second animal which, however, recovered, was the pet and playfellow of four little girls, who grieved at the illness of their favourite, nursed it with great care. All four girls developed diphtheria, their mother being convinced that they got it from the cat, and indeed no other known source of contact with infection could be discovered. It is easy to imagine cats catching an infectious illness like diphtheria, when we remember how often milk and other unused food from the sick room is given to the cat, or by some people thrown out in the backyard for the benefit of the neighbours' cats, if they have none of their own. It is a frequent occurrence to see children carrying cats in their arms, and even kissing them. It is obvious that if the cat were ill with diphtheria, the children under such circumstances would almost inevitably contract the disease.

In the account afforded by this report of conditions paramount in, or conducing to, epidemicity of diphtheria in Enfield, consideration has not as has been said, been given either to the beginnings there of the disease or to the meaning of its persistence during several years in the district. The subject has heretofore proved of exceptional difficulty even in purely rural localities where appearance of diphtheria has been recent, and where the conditions of its prevalence had seemed beforehand to be simple and correspondingly easy of study. Much more difficult, therefore, the problem in Enfield where diphtheria has long been domiciled,

and where the conditions of its persistence are of almost infinite complexity. As matter of fact, it has not been found possible under the actual circumstances of Enfield, to form any estimate of the influence that a variety of unwholesome conditions, commonly believed to have concern with diphtheria, may have had on the abiding quality of the disease in the place, and accordingly, while neither affirming nor denying relation of insanitary circumstances to the diphtheria witnessed, the remainder of this report is given to an account of the chief sanitary improvements effected in Enfield since Dr. Parsons's visit in 1880, with indication of the direction in which further improvement is more especially needed.

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No. 15.

Report on the Sanitary State of the adjoining Urban Sanitary Districts of Clee-with-Weelsby and Great Grimsby, with reference to the Prevalence of Enteric Fever there; by Dr. Page.

This inquiry was ordered by the Board in view of an excessive mortality from typhoid fever shown in recent returns, made to the Registrar-General, to have prevailed in the Great Grimsby sub-district of the Caistor Union. I visited the district, as directed, on April 17 and following days.

In 1881 Dr. Parsons inspected the Borough of Grimsby, and in his report to the Board he refers to the growth of the town as extending beyond the municipal limit into the local board district of Clee-with-Weelsby. During the half-dozen years that have since elapsed this process has been going on apace, and at the present time Clee-with-Weelsby, or, as it is generally spoken of, New Clee, forms, for all save purely administrative purposes, a considerable part of the town of Great Grimsby.

New Clee: *Urban Sanitary District.*

New Clee.

This district lies on the south-east of the borough proper, and comprises an area of 2,557 acres. In 1881 the population was 11,620, living in 2,036 houses. It is now estimated at upwards of 17,000, or nearly half the population of the adjacent borough of Grimsby, from which it is an outgrowth. The number of inhabited houses is 3,462. Topographically the site of the district is flat, and abuts on the foreshores of the Humber, between Grimsby Docks and the popular seaside resort of Cleethorpes. The whole area is but little above high water of spring tides, and geologically consists of beds of recent deposits, estuarian warp or mud on the surface and permeable sands and stiff clay below, overlying the Chalk at a depth of 80 or 90 feet. This formation is seen cropping up inland, in the west, along the Lincolnshire Wolds. In the beds of recent deposits upon which the district stands, water is said to be commonly met with at a depth of some 5 or 6 feet from the surface.

The population of New Clee is almost wholly employed in the fishing industry and subsidiary trades of the Port of Grimsby.

House accommodation.

Some of the older property in this district, as in Charles and Humber Streets (one side of the latter street being within the borough of Grimsby), is very closely built, with small confined backyards, rendering impossible free movement and circulation of fresh air. In both of these localities a number of cottages are met with arranged in courts or terraces approached from the streets through narrow passages between the line of houses, and in Charles and Victor Streets there are some 90 small back-to-back houses, many of which, though occupied by single families, are overcrowded. Elsewhere, in its newer parts, New Clee is laid out in streets of good width, with four to six-roomed artizans' dwellings having commonly ample yard space, and not unfrequently plots of garden ground at the rear. Backways are flagged as a rule, but some still unmade and in an almost impassable plight from wet and dirt were encountered, as for example, behind Victor, Guildford, and Heneage Streets.

Water supply.

A few houses only are dependent upon private wells, not more I am told than half-a-dozen in number, the general water supply of the

district being obtained from the works of the Grimsby Water Works Company. These works were constructed in 1862, and pump a supply from artesian borings in the chalk at Cleethorpes and Little Coates, whence it flows directly into the mains and is distributed on constant service, without the intervention of storage cisterns, to houses in Grimsby, New Clee, and Cleethorpes. The water is stated to be of excellent quality.

Excrement removal.

As in Grimsby, midden privies have been abolished, and a form of closet is in general use wherein a rectangular wooden box is the receptacle for both excrement and house refuse. There are not more than 350 waterclosets in the district, all of which are provided with proper flushing apparatus. Scavenging of the wooden receptacles is done by contract and is carried out during the night at intervals of 10 to 14 days, the boxes being simply emptied into water-tight but open carts and replaced. In the course of my inquiry I noticed overfull and leaky boxes, and having regard to the objectionable mode of collection, there can be no question that it would be in the interests of the public health that the Authority should undertake the scavenging of their district by their own servants, and thus secure more frequent removal. If properly designed boxes or pails with close fitting lids and covered vans were provided, this removal could be effected in daylight, so that the receptacles might be effectually cleansed.

Sewerage.

In 1882, the joint intercepting sewer spoken of in Dr. Parsons's report as about to be constructed at the joint cost of Grimsby Corporation and Clee-with-Weelsby Local Board was laid down. It receives the whole of the sewage of New Clee and of the larger and more densely inhabited portion of Grimsby. Commencing with a diameter of two feet, it increases to a diameter of 4 feet 6 inches, and after receiving main culverts from both districts and the East Marsh or Clee drain, is continued in an outfall of 7 feet diameter constructed by the Manchester, Sheffield, and Lincoln Railway Company, to its point of discharge into the Humber to the east of the fish dock.

The Clee drain referred to is an agricultural dyke traversing the district, partly covered and partly open and forming, at places, the line of boundary between Grimsby and New Clee. It formerly received sewage and refuse matters from fish-curing houses along its banks, but these have been diverted by the construction of the conjoint main sewer described. The latter is provided with closing doors at its outlet which is tide-locked for about six hours in every twelve, and during this interval, sewage and drainage waters are backed up and stagnate in the sewers. This main sewer is not provided with any effectual means of ventilation. Since its construction a considerable part of New Clee has been sewered, the chief district sewer being an egg-shaped brick culvert 3 feet 6 inches in diameter passing along Oxford Street, and joining the combined main sewer in Albion Street, Grimsby, at which point it is furnished with a tidal valve. The smaller sewers of the system are of pipes ranging from 2 feet to 9 inches in diameter.

Means of ventilation for the district sewers have been provided by surface gratings at manholes at frequent intervals along their course, but this provision has been defeated by the obstruction of the several openings by deep trays of charcoal, through which no current of air could by any possibility penetrate. Flushing is said to be systematically carried out once a fortnight. Save at one point in Charles Street, an examination of several sewers showed a satisfactory freedom from deposit.

House drainage.

Few houses have sinks indoors, these being conveniently placed outside in the backyard below the watertap. In some houses with indoor sinks, the pipe was found to communicate directly with the drains,

and the small belltrap was found displaced, allowing, as experiments showed, steady indraught of foul air into the dwelling. The yard sinks are almost without exception of faulty construction and consist of a large catchpit, locally and appropriately termed a cesspool, constructed commonly of brick and trapped either by a vertical flagstone or loose iron trap. In the latter instance there is nothing to prevent the escape of sewer air into the yard, and this in effect was found taking place as might be expected under such conditions. These catchpits hold several gallons of slopwater and more or less of solid matters, and are emptied at the instance of the Authority who contract with a person to effect this emptying at intervals of three months. Watercloset soil pipes are inadequately ventilated by 2½-inch pipes instead of being carried up in full diameter as required by the byelaws, and similarly, the proper ventilation of house drains, although provided for by the byelaws, is in no instance carried out, rain water pipes being in general use for this purpose.—So that in effect it may be said that under existing circumstances of sewer ventilation throughout the district the only ready means of exit for sewer air has been on and about house premises. The foul condition of the contents of several of the sewers and their branches has been further aggravated by the construction of large catchpits or cesspools on the line of some of the drains common to a row or street of houses, these, as in the case of the yard cesspool, being likewise looked after by the person who contracts with the Sanitary Authority.

Sanitary administration.

Mr. Richard Brocklesby, M.R.C.S., is Medical Officer of Health at a salary of 25*l.*, one half of which is repaid from the Parliamentary Grant. Mr. Brocklesby is also Medical Officer to the No. 2 district of Caistor Union, comprising New Clee, Cleethorpes, and the N.E. ward of Great Grimsby. As Health Officer he makes frequent inspections of his district and advises his Authority upon its sanitary circumstances and requirements. The duties of the office of Inspector of Nuisances devolve upon the Surveyor to the Authority, Mr. Coulson, an energetic officer, but whose special duties render the efficient discharge of his other important office quite impracticable. The appointment of someone giving his whole time to the work of constant and systematic nuisance inspection is a matter of pressing necessity.

The Local Board was formed in 1878. Since then the following loans have been sanctioned by the Local Government Board :—

Purpose of Loan.	Amount.	Date of Sanction.
	£	
Offices and site - - -	2,000	28th May 1879.
Sewerage works - - -	3,000	13th September 1881.
Ditto - - -	1,000	24th December 1884.
Ditto - - -	3,500	7th August 1885.
Paving works - - - -	6,500	Ditto.

In April 1880, the Board's model byelaws for the prevention of nuisances, the regulation of common lodging-houses and slaughter-houses, and with respect to new streets and buildings were adopted. But with the exception of houses in Guildford and Bedford Streets built upon made ground occupying former brick ponds, the important sanitary clauses relating to the concreting of the sites of dwelling-houses and to the ventilation of house drains, have not been enforced. Yet these provisions are of great and special importance throughout such a district as this.

Slaughter-houses.

The condition of the private slaughter-houses, nine in number upon the register, calls for no special remark.

Milk shops.

Milk shops are registered, but have not yet come under systematic inspection.

Disinfection.

The Authority have made no provision for the disinfection by heat of infected articles of clothing and bedding.

Hospital accommodation.

In consequence of the appearance of small-pox in the district in December last, and the refusal of the Grimsby Sanitary Authority to admit cases from New Clee into their hospital, the Local Board proceeded with the erection of a four-warded wooden pavilion which was opened for the reception of patients on March 17. It occupies a site of $1\frac{1}{4}$ acres, 550 yards distant from the nearest dwellings, fenced around with close boarding 6 feet high, and is constructed of double match-boarding with an interspace of $4\frac{1}{2}$ inches filled with sawdust. The foundations are of brick, and the roof of boards covered with felt. Water is laid on from the mains, and the drains are connected with the district sewers. Since the beginning of the outbreak until April 27, 107 cases of small-pox are known to have occurred, of which 58 have been removed to the hospital.

Borough of Great Grimsby: *Urban Sanitary Authority.*

Great Grimsby.

As regards the sanitary condition of the Borough of Grimsby, the chief improvement effected since Dr Parsons's visit in 1881, is the construction of the conjoint main sewer already described as taking the sewage of New Clee and of the chief part of Grimsby. The rest of the town, comprising parts of the north-west and south-west wards, drains as formerly into the Haycroft drain, which has its outfall at the Pywipe Sluice on the west side of the docks. I cannot learn that anything beyond the construction of this one sewer has been done to give effect to the recommendations appended to Dr. Parsons's report, nor with the exception of some minor improvements, to the later recommendations consequent upon Dr. Blaxall's visit in 1885.

Continued use of well water.

Wells to the number of between 70 and 80 are in use in different localities, no comprehensive action having yet been taken (beyond the closure of such as have actually been condemned on chemical analysis) for their abolition and for substitution of the town water, although the Medical Officer of Health has had reason to attribute frequent occurrences of typhoid fever to these wells, and the Authority themselves recognise, in the character of their surroundings, the dangers of these local supplies. Among some well waters recently sent for chemical analysis, were two taken by Dr. Newby, and Mr. Moody, the Inspector of Nuisances, one from a pump-well supplying 10 houses in Duncombe Street, into which the yard cesspool was discovered to leak, and the other from a pump supplying six houses, but since closed, which shortly before yielded water of a "stinking and undrinkable character." Yet the results of analyses of the samples in question appear to have led the analyst to the following conclusions: "Water of a very high degree "of purity, and if drawn clear of deposit, everthing that could be "desired"; and, "seems to have received salt water to a small extent, "fairly good water if allowed to stand to allow the slight deposit to "subside." The instance is a good one, as showing the need for other than chemical observation of the characters of a water supply.

Excrement disposal.

There are, it is stated, some 1,150 waterclosets and 5,700 box privies in the borough, the latter being emptied by contract at intervals of 10 and 14 days, during the night and into open carts, as in New Clee. The Borough Surveyor has specially reported to the Sanitary Authority

upon the evils of the present method of excrement removal, recommending the adoption of a properly carried out pail system, but so far nothing has been done.

Sewerage and house drainage.

The sewers are without adequate means of ventilation or provision for flushing, although both outfalls are blocked at every tide for some five or six hours, or even longer. During this interval the sewage is stagnant in the sewers, and the chief available means of escape for the foul air is by rainwater pipes and the defective traps of sinks and catchpits on house premises over the town. These catchpits or "cesspools" are in themselves most objectionable elements in house drainage arrangements, allowing foul accumulation of solid and liquid refuse for periods of two to three months, when (it is said) they are emptied by contract on behalf of the Authority.

The Borough Surveyor has reported on the main drainage of the borough during the recent prevalence of fever, and refers to the question of flushing and ventilation of the sewers in connexion with recommendations for efficient provision for these purposes. The following passages occur in his report:

"Owing to the absence of any great amount of fall the sewers of Grimsby require special attention in the matter of flushing in order to keep them clean and free from deposit, and this remark applies more particularly to the branch or minor ones than to the main sewers which are to a great extent clean and in fair condition.

* * * *

"The greater number, however, of the sewers are unprovided with lamp holes or manholes whereby flushing and inspection can be carried out, and this should be remedied as soon as possible. This is a serious deficiency of the sewerage system, for it is utterly impossible to keep the sewers clean and in good order without a constant and systematic inspection. Under the present arrangement, if a stoppage occurs in any of our sewers, I have to set men to break away the street and work down to the sewer at various points until the obstacle is arrived at and this is a serious cost to the town; not to mention the inconvenience to traffic and the damage to the surface of the road. Whereas, if manholes were made and surface covers were placed on the sewers, at the intersection of one sewer with another, and a further manhole or lamphole were constructed at the upper or dead ends of each branch sewer, the question of a stoppage could be settled in as many minutes as it now takes hours. These ventilating manholes and lampholes should never be more than 100 yards apart, and should be placed at every change of direction and gradient of the sewer.

* * * *

"The sewerage system as regards its ventilation is practically unprovided with any effectual means of escape for foul gases, as owing to the absence of ventilation by the requisite number of proper surface gratings, and shafts at frequent intervals, the sewer air is forced out at the weakest points of resistance, and these are the street gullies and yard cesspools, and inside houses, the waterclosets and baths.

"The rain-water spouts too act as ventilators, but these I consider a most dangerous channel for the relief of sewer gas, which escapes from the joints owing to their never being properly cemented, and from these openings and the head at the top the noxious vapours are discharged in close proximity to the windows of dwelling-houses."

Byelaws.

These important matters are, I am informed by the Town Clerk, now under the immediate consideration of the Sanitary Authority. So also the present byelaws relating to house drainage and new buildings,

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On the Sanitary State of Clee-with-Weelsby and Great Grimsby, with reference to the Prevalence of Enteric Fever there; by Dr. Page.

dated 1861, are now undergoing revision on the basis of the Board's model series.

Hospital provision.

Certain of the improvements of the existing hospital for infectious diseases suggested by Dr. Blaxall at his visit to Grimsby in 1885, have been made; but the chief of them, namely, provision for separate treatment at one and the same time of two different infectious diseases, has only been begun under stress of the current small-pox epidemic. A two-warded brick building, to hereafter afford facilities for such separation of diseases, is now in course of erection, its immediate purpose being the housing of convalescent small-pox patients. Nothing has yet been done to remedy the insecure enclosure of the site, about $1\frac{1}{4}$ acres, which is still merely fenced around by open posts and rails.

A hot air disinfecting stove has been provided, consisting of an iron chamber heated with gas, but of questionable efficiency; the caretaker informing me that he finds it difficult to avoid scorching the clothes and other things submitted for disinfection.

Port sanitary administration.

As a result of Dr. Blaxall's visit, Grimsby was constituted a Port Sanitary District, and the Town Council, as Port Sanitary Authority, have appointed an Inspector of Shipping, who gives his whole time to the work. The advantages of systematic inspection of vessels have been shown during the present outbreak of small-pox, since of 174 cases admitted to hospital at the time of my inquiry, 26 had been removed from fishing vessels. These were smacksmen who, residing in Grimsby and New Clee, had sickened of the disease while at sea.

Fever and other Infectious Diseases in New Clee and Great Grimsby.

Zymotic and infant mortality.

The following table gives the total number of deaths from infectious diseases, and the rate per 1,000 births of children dying within the first year of life in each of the eight years 1880–87 in New Clee and Great Grimsby respectively.

Infant Mortality and Mortality from Epidemic Diseases.

Year.	New Clee Urban Sanitary District. Population in 1871, 2,053. In 1881, 11,620. Estimated in 1887, 17,000.								Great Grimsby Urban Sanitary District. Population in 1871, 20,244. In 1881, 28,603. Estimated in 1887, 35,000.							
	Small-pox.	Measles.	Scarlatina.	Diphtheria and Croup.	Whooping-cough.	Fever.	Diarrhœa.	Deaths under 1 Year per 1,000 Births.	Small-pox.	Measles.	Scarlatina.	Diphtheria and Croup.	Whooping-cough.	Fever.	Diarrhœa.	Deaths under 1 Year per 1,000 Births.
1880	—	7	—	2	1	1	16	141	—	14	6	4	4	4	41	160
1881	—	1	5	2	3	2	4	107	—	1	2	1	18	8	14	136
1882	—	5	33	1	12	4	10	159	—	13	49	1	7	15	37	146
1883	2	1	33	—	4	1	8	147	4	—	73	3	4	7	22	132
1884	—	—	—	1	6	2	28	161	—	2	3	4	11	7	59	200
1885	—	9	—	—	10	2	7	137	—	21	1	3	12	8	15	158
1886	—	—	—	3	5	4	22	125	—	—	2	2	5	7	63	176
1887	1	6	1	—	10	17	42	164	12	19	7	4	8	23	53	183
8 years	3	29	72	9	51	33	137	143	16	70	143	22	69	79	304	161

A comparison of the two districts shows, when difference of population is taken into account, a remarkable similarity in the average mortality in the whole period from the more important of the above diseases. This is notably the case in regard to the fever and diarrhœa mortality, and a circumstance of significant interest in relation to what has already been told of the identity of both districts as to character of population and physical and sanitary conditions.

Deaths from typhoid or enteric fever year by year indicate the habitual presence of this disease. Last year it prevailed to an unusual amount, and was accompanied by an excessive mortality.

A list which I have prepared from returns furnished to Dr. Brocklesby by medical practitioners in New Clee, comprises altogether 55 households in which 120 cases of fever occurred during last year and thus far (April 25th) into the present year (1888). Of these 21 ended fatally, or about one in six,—a high rate of mortality.

Typhoid fever.

In Grimsby for the same period less complete returns of sickness have been obtained, but lists received by Dr. Newby include 102 households and some 140 cases of fever, of which 26 have proved fatal, a rate of mortality nearly corresponding with that observed in New Clee. The next table shows the distribution of deaths, and, so far as information obtained in the course of inquiry into the circumstances of the outbreak is available, of households attacked month by month in each district.

New Clee.

Great Grimsby.

Months.	New Clee.		Grimsby.		
	Deaths.	Households attacked.	Deaths.	Households attacked.	
1887.					
January -	—	—	—	—	
February -	—	1	—	—	
March -	1	1	1	4	
April - -	—	—	1	6	
May - -	—	1	1	3	
June - -	—	3	2	8	
July - -	—	8	—	4	
August -	3	14	1	8	
September -	7	10	6	20	
October -	1	1	5	10	
November -	3	2	1	8	
December -	2	1	5	11	
1888.					
January -	1	2	2	2	
February -	3	1	4*	2	*3 in one family.
March -	—	—	—	—	
April (25th) -	—	—	2	2	
Total -	21	45	31	88	

As to other 10 households in New Clee and other 14 in Grimsby, information about the dates of attack was not to be had. Secondary cases occurred in several of the invaded households in both districts. In one family eight persons were one after another attacked; in another six; five in a third; four each in five households: three each in five others; and two each in other five. In four households two deaths each occurred, and in one family there were three deaths. It will be noted that both in regard to sickness and mortality, typhoid fever showed its usual seasonal prevalence.

As regards locality, in both districts the fever has been pretty generally although irregularly distributed, not confined to any particular area or group of streets, but attacking households in different parts of Grimsby and New Clee. Separate localities became attacked about the same time, while the dates of attack of the affected households in the same locality differed in consequence of the recurrence of fever at later periods of the outbreak. Thus, in the neighbourhood of Humber

Street, New Clee, five families were attacked, but at successive dates, between June and September. The poorer neighbourhoods have been chiefly affected.

The whole of the circumstances of the fever prevalence are, from what has been said of its endemic existence, strongly suggestive of local insanitary conditions, common to both districts, and of a persistent sort.

There was no evidence against the milk supply, although in two instances milk had been sold uninterruptedly throughout illness from two infected households. In both instances the sale was to a limited number of customers only, and upon them there had been no special incidence of fever.

There is no reason to suspect the general water supply, but it is otherwise as regards the local wells, from which some of the affected households drew their supplies. These wells are subject to risk of specific contamination such as to suggest that these sources of water supply had some share in the whole prevalence of fever. As a more strictly localised cause of infection, instances came under notice in which it appeared to me that the illness of successive members of a family had been due to the use of a box-privy into which the infected discharges of an earlier case had been thrown. But more frequently I found that such discharges were habitually disposed of during illness down the yard drain-inlets and catchpits—even down inside sinks—with a view to avoid infection of the privy-receptacles; and in this way I suspect a more intense infection of some of the smaller and defective drains was brought about, as in Humber Street, for example, while the practice is like enough to have led to a general infection of the sewers. In the greater number of invaded households, examination of their sanitary arrangements revealed the existence of defects which, in the unventilated state of the public sewers along with faults of private drainage already described, offered abundant facilities for the escape of sewer air into and about the dwellings. Such sewer air could not fail at times to be charged in greater or less degree with the infection of enteric fever. In certain houses wherein fever had occurred, complaint was made of bad smells, not from any inlets or other obvious connexion with the drains, but from points of the flooring indoors, as if dependent upon emanations from a polluted soil below.

Reviewing the whole prevalence of fever now shown to have been common to the two districts, there can be no question that these dangerous defects of sewerage and house-drainage must be held responsible for this unusual amount of sickness, just as they are no doubt responsible for the habitual presence of the disease in the districts. Probably the special spread and virulence of attack during last autumn, may be ascribed to the heat and drought of that season. The pollution of wells by excremental matters must be considered to have played a part in the epidemic.

No. 16.

Report upon a Prevalence of Typhoid Fever locally ascribed to certain Slaughter-house Premises at New Brighton, near Birkenhead; by Mr. John Spear.

In October 1887 complaints were forwarded to the Board respecting the carrying on of the business of slaughtering in a populous locality of New Brighton, in the Wallasey Urban Sanitary District; and it was alleged that typhoid fever had broken out in consequence of the emanations from a certain slaughter-house there situated. Asked to report upon the subject, the Medical Officer of Health affirmed that the business was carried on without nuisance, and was unconnected with the appearance of typhoid fever. Complaints, numerous and urgent, continued, however, to be received from residents of the locality, and in July 1888 it was reported that typhoid fever had again broken out, and was, in the opinion of the complainants, clearly traceable to effluvia arising from the slaughter-house premises. Again, in a letter dated September 14th, 1888, it was alleged, "the neighbourhood was "free from fever previous to slaughtering; since then it has not been "clear, except from October 1887 to June 1888, when slaughtering "was not allowed." In view of these representations I was instructed to visit the locality and make inquiries on the spot.

On the 13th November I attended at the Wallasey Local Board Offices. The Chairman and several of the members of the Local Board, with their legal adviser, Medical Officer of Health, and Surveyor, were present, as well as the occupier of the slaughter-house, and certain of the complainants with their solicitor. The circumstances of the case, together with the opinions that had been formed on either side, were, as far as possible, elucidated,—a task in which I received every assistance from the legal gentlemen present,—and I then proceeded with my own personal investigation. I will deal first with the slaughter-house, the special subject-matter of complaint, and then with the fever prevalence.

For many years slaughtering has been carried on on the premises in question, but between 1876, or thereabouts, and 1883, there was an interval, and hence at the later date the business could only be re-established with the concurrence of the Sanitary Authority; indeed, in 1878 a conviction was obtained before the Justices against the then occupier for slaughtering without licence.

In November 1883 the present tenant commenced slaughtering. Complaints were soon made to the Sanitary Authority, and the Medical Officer of Health and Surveyor were required to report upon the subject. Both expressed themselves (May 1884) not unfavourably, on the whole, in regard to the construction and condition of the premises, but both took exception to the situation; . . . "but the situation "is objectionable," the Medical Officer of Health reported, "because "so closely surrounded by dwelling-houses, to the occupants of which

"the slaughter-house may prove a nuisance." . . . . "I think if "much slaughtering were carried on there, especially of pigs, it would "cause a nuisance." As a result, the Sanitary Authority refused the licence which had been applied for, but a private communication was conveyed to Mr. Scott, the occupier, from the Health Committee, to the effect that so long as he continued to slaughter without nuisance his business would not be interfered with. This arrangement, if so it may be called, continued until the autumn of 1887, some 30 sheep and two oxen being slaughtered on the premises weekly, when in October, in consequence of the renewed complaints, some of which, as already stated, reached the Board, proceedings were taken against Mr. Scott for slaughtering without licence, and a conviction obtained.

Meanwhile the Sanitary Authority had decided against the erection of a public abattoir, and now, no doubt, Mr. Scott, although allowed the use of his brother's licensed premises at Seacombe, some two miles distant, was put to considerable inconvenience. An agitation to secure for him the licence that had been denied was commenced, and the subject was again before the Sanitary Authority in June 1888. Mr. Salmon, the Surveyor, then advised the Authority unequivocally against the granting of a licence. In answer to questions put to him he stated that he had never said that Mr. Scott's premises were in every way suitable for a licence. "He said they were in an overcrowded neigh-"bourhood, and if for no other reason, they were totally unsuitable." The Medical Officer of Health, on the other hand, stated that he had never found the slaughter-house in question to cause any nuisance, and, asked whether he considered the situation suitable, declined, with the permission of the Chairman, to answer. It will be remembered, however, that he had already reported the situation to be objectionable, so that it cannot be said that the Authority were left with imperfect information. At any rate, it was decided by a majority of eight to five to grant the licence. This was on June 7th, and on July 7th (after the next meeting of the Authority) the licence duly signed was forwarded to Mr. Scott.

The evidence is conflicting as to whether slaughtering was commenced on the earlier or the later of these two dates, and the point is considered by the complainants as of importance, since two of the cases of typhoid fever, alleged to be due to emanations from the slaughter-house, made their appearance previous to July 7th. Mr. Scott, it appears, on June 8th wrote to the Clerk to the Sanitary Authority asking if he were then at liberty to use his slaughter-house, and receiving what he considered an undecided reply, resolved, so he affirms, to wait for the licence. In this statement he is supported by his slaughterman, an apprentice, the person who received garbage from his slaughter-house, and a monthly nurse employed at the time in his house. On the other hand, his next-door neighbour, Mr. Dolan, whose wife sickened of typhoid fever on July 3rd, is positive that slaughtering commenced on June 12th, and produces notes which purport to be a daily record of slaughtering from June 12th to July 2nd, which are said to have been taken at the time by a shopwoman in his employment, and are vouched for by her. The amount of stock bought by Mr. Scott at this time appears to have been from 30 to 50 sheep per week, and some three oxen.

The shop and dwelling-house, the former large and commodious, stand as part of a row of shops and dwellings in Victoria Road, the main street of New Brighton. The height of the houses here is about 32 feet from the ground level, and the premises at the back have

become by successive additions much confined. The space from the rear main walls to the back lane measures on an average some 40 feet, but the greater part of this is now covered by various outbuildings; some being extensions from the houses in their original construction, and others stables, sheds, &c., put up for trade purposes. Taking eight houses of this row, of which Mr. Scott's is the fifth, from Mason Street corner downwards, the following figures show approximately the amount of yard space that would have been available had the area from the main walls remained vacant, and the open space that actually exists.

No. 1. Area at rear from main walls to back lane, 1,400 square feet. Uncovered yard spaces at rear, 330 square feet.

No. 2. Area at rear from main walls to back lane, 528 square feet. Uncovered yard spaces at rear, 85 square feet.

No. 3. Area at rear from main walls to back lane, 1,000 square feet. Uncovered yard spaces at rear, 315 square feet.

No. 4. Area at rear from main walls to back lane, 1,000 square feet. Uncovered yard spaces at rear, 371 square feet.

No. 5. Area at rear from main walls to back lane, 1,440 square feet. Uncovered yard spaces at rear, 465 square feet.

No. 6. Area at rear from main walls to back lane, 2,365 square feet. Uncovered yard spaces at rear, 190 square feet.

No. 7. Area at rear from main walls to back lane, 900 square feet. Uncovered yard spaces at area, 480 square feet.

No. 8. Area at rear from main walls to back lane, 450 square feet. Uncovered yard spaces at rear, 72 square feet.

It will be seen that nearly three fourths of the area behind these buildings, between the rear main wall and the back lane, is covered over—partly by high extensions from the main buildings, such as are unfortunately more or less general in most towns, but largely also by less legitimate erections, viz., sheds; stables (5); manure pits; slaughter-houses (2, including the one newly licensed); lairs for cattle and sheep-pens. Besides the cattle and sheep kept for the purpose of slaughter at the two slaughter-houses, eight and sometimes nine horses and ponies are stabled in the confined back premises of these eight dwellings, and manure is allowed to accumulate sometimes for a month before removal. The back lane itself is only 12 feet wide, and abutting upon it on the opposite side are the yards, some 15 feet deep, of Richmond Terrace, small tenement property.

Briefly, the area in which this slaughter-house has been established may be said to be small and crowded, surrounded at almost every point by high buildings, and containing already a quite unusual number of sources of aërial contamination.

The slaughter-house in question is situated in No. 5 of the yards above described. The building, which was originally it is said a cart-shed, is of brick and open to the slated roof. It is in dimensions 14 feet by 10 feet 3 inches, and possesses a well-constructed floor of cement concrete sloping to a trapped gully in the centre, which gully communicates, however, directly with the house-drain passing beneath the floor of the dwelling.

The height of the building to the eaves is 13 feet, and to the apex of the roof 16 feet; the ventilation, apart from the doors, one of which opens from the back-yard, another from the back lane, and a third into a stable, is insufficient. The yard which intervenes between this building and the main wall of the house is 31 feet 9 inches in depth,

and although receiving some of the splashings from the slaughter-house, and the oozing of animal matter from hides, &c., often deposited on the yard, the surface is only paved roughly with porous bricks. Water is supplied to the slaughter-house by tap from the public mains, and a hose pipe is used for the purpose of washing the interior. A tank likewise, for the collection of rain water from the roof, is situated just beneath the surface of the yard spoken of, and possesses an overflow to the slaughter-house drain. The water pumped from this tank has been complained of by the neighbours as so foul that the atmosphere at the back of the houses is polluted by it, but at the time of my visit this objection was not apparent.

At one side of the slaughter-house, and opening from it, is a stable where one horse, and sometimes a horse and pony are kept. This place is ill-ventilated, and immediately adjoining, and with open communication, is a large manure pit, said to be emptied once a week. Abutting upon this again is a large ash-pit, the contents of which are only emptied monthly, and an ill-flushed water-closet with corroded pan. Between the building formed by the stable, &c., and the house-wall on that side, only a narrow passage of yard space, 3 feet by 14 feet, is left. This limited space is roughly paved, has opening on to it the ash-pit and water-closet above referred to, and here sheep are penned previous to slaughter.

The premises afford no facility whatever for the lairage of cattle, and accordingly Mr. Scott rents a two-stalled stable in the yard of the York Hotel two doors from the slaughter-house. It is a small, badly-ventilated, ill-paved place, and the space from the door right up to the back-door of the hotel is roofed with glass. At the time of my visit, two heifers and six sheep were penned here, and one of the latter received as I looked a severe kick from a heifer about whose heels the sheep are compelled to crowd.

Speaking of the slaughter-house itself, so far as general tidiness can secure freedom from nuisance in a place so closely situated and slenderly provided there is no doubt Mr. Scott strives for this result. Blood and garbage are removed promptly after slaughter, and the place is as clean as the structural arrangements allow.

Whatever may be thought of the proceedings relating to Mr. Scott's licence, and whatever may have really been the effect of this slaughter-house upon the public health, it is to be regarded as a serious error of judgment to have allowed such a business to be established in such a neighbourhood.

In 1877 the Local Government Board issued to Urban Sanitary Authorities a set of "rules" as to site and structure of slaughter-houses, advising the Authorities that in the exercise of their discretionary powers of licensing such places these rules should influence their decision. The communication in question was referred to at the meeting of the 13th November at the Local Board Offices, and was apparently well known to the Authority. Nevertheless, a perusal of these rules, which are printed at the end of this report, will show how seriously they were departed from when the licence in question was granted.

There are other slaughter-houses in the district in an unsatisfactory condition. The one already referred to as in the same row with Mr. Scott's, is not only in a confined situation but is badly paved and dirty; one that I visited at Liscard was approached by a filthy back lane, the surroundings were sloppy and neglected, and offal was deposited in the midden.

Fever Prevalence.

Referring to the urban sanitary district of Wallasey as a whole, it covers an area of 3,408 acres, and contains a population of some 32,000. The geological formation is that of the new red sandstone, with superficial alluvial deposits—clay, marl, sand, and gravel. Generally speaking the natural position of the district is exceedingly favourable, well elevated, and swept by sea breezes. The population is grouped into five or six detached villages, New Brighton, Liscard, Egremont, Seacombe, Poulton, and Wallasey, but for statistical purposes the old township divisions are taken. These townships are three in number—(1) Liscard (including New Brighton), with an estimated population of 15,545; (2) Seacombe, including Poulton, estimated population, 14,201; (3) Wallasey, population, 2,044. I have annexed to this report certain mortality statistics, and available returns of sickness from fever, relating to the district and to the several townships.

The average annual mortality rate from typhoid fever, for the four years and ten months, January 1884 to October 1888, was, for the whole district, equal to ·22 per 1,000 of the population. In the various townships the corresponding average was ·17 in Liscard (including New Brighton); ·32 in Seacombe, and ·10 in Wallasey.

The Medical Officer of Health obtains returns of sickness from dispensary, but rarely from private practice; and as of course the former lies mainly in the poorer localities, the returns are of comparatively little value in showing the relative localization of disease. So far as they go they coincide with the mortality returns in indicating a greater average prevalence of typhoid fever in the Seacombe township. This latter contains, however, the poorer population.

New Brighton consists chiefly of several streets and rows of smaller dwellings situated on the sea-front, on sandy soil gradually sloping from high-tide level. On the hillside above there are a number of villa and terrace houses, but the lower locality contains some two-thirds of the population of New Brighton, and the inhabitants are engaged for the most part in occupations incidental to a seaside resort of the poorer class and of excursionists.

It is the opinion of medical men practising in the neighbourhood that the health of this lower locality is decidedly inferior to that of other parts. Typhoid fever makes its appearance more frequently; it is said that scarlatina is more fatal and persistent; that sore throats are more common; and that women after childbirth are apt to do less favourably. As to typhoid fever, so far as I have been able to ascertain, there have been, during the last two years, 20 cases in 17 different families living in New Brighton. With one exception, these cases have all occurred in the lower locality, and in the exceptional one, the sufferer (a policeman) frequented that part in pursuit of his occupation; and this was the case also as regards an isolated attack that occurred in another township. It may be said then that, during these two years, 21 attacks, in 18 families, are to be considered in connexion with the subject of fever prevalence in this lower locality. The time of their occurrence was as follows:—

—	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1886 - - -	—	—	—	—	—	—	—	—	—	—	—	1
1887 - - -	2	1	1	—	2	—	—	2	—	—	—	—
1888 - - -	—	—	—	—	—	1	4	4	2	—	1	—

Persons of all ages and of both sexes suffered. Nine cases were amongst children under 16, and 12 above that age; 8 males and 13 females were attacked.

As to locality, the following streets were implicated; Balmoral Road, 5 cases; Egerton Street, 3 cases; Richmond Terrace, 4 cases; Victoria Road, 1 case; Windsor Street, 4 cases; Richmond Street, 1 case; Marine Hotel, 1 case. A policemen, living elsewhere but having his beat in this locality, was attacked, as well as a boy living elsewhere, but employed in a shop in Victoria Road. The case in Richmond Street was that of a boy employed likewise at the same shop.

The closely covered area about the slaughter-house suffered severely, and there was a small grouping of cases on the south side of Balmoral Road, and another in Victoria Terrace, Egerton Street, but the cases are too few to speak of any marked localization. If the slaughter-house be taken as a central point, in successive areas, each of 50 yards, there is found the following proportion of infected dwellings:—

Within a circle of 50 yards radius, 35 houses: 4 family invasions, two attacks in lads employed at a shop within the area, but living elsewhere (including these two, 7 cases).

Within a zone of 50–100 yards, 95 houses: 3 family invasions (4 cases), one sufferer was one of the two employed at the shop spoken of above.

Within a second zone of 100–150 yards, 158 houses: 6 family invasions (7 cases).

Beyond that area (but within the lower locality of New Brighton), 244 houses; 3 family invasions (3 cases).

(The case of the policeman beyond the area designated is not classified.)

The history of the cases immediately about the slaughter-house, so far as I have been able to recover it, is briefly as follows: In January 1887, a woman living at 5, Richmond Terrace, some 13 yards distant from the slaughter-house, and a little nearer the lairage, was fatally attacked by the fever. It was a single case in the house, and the family have now removed. A woman who washed the clothing of the deceased contracted the disease, as well as a second woman residing with the one last named. These two sufferers lived in the Balmoral Road, 100 yards from the slaughter-house, or just within the second radius; and in considering all possible causes of their infection, it has to be noted that in December 1886 a case of typhoid fever had occurred in another house in Balmoral Road. In August 1887, two persons living at No. 6, Richmond Terrace, next door to No. 5, and a little nearer still to the slaughter-house, were infected. Both recovered, but this family also had removed at the time of my visit. The immediate locality (and indeed the whole within 100 yards of the slaughter-house) was free from fever until July 2nd, 1888, when Mrs. Dolan, living next door to Mr. Scott's, within half-a-dozen yards of the slaughter-house) was fatally attacked; and, on the same day, a lad working in Mr. Snow's shop, next door to Mr. Dolan's on the other side, sickened; the case likewise terminating fatally. A little later a second boy employed on the same premises (Mr. Snow's), but living at some distance, passed through an attack of what was called at the time pneumonia, but which there seems reason to believe was really one of fever. Then, on July 28th, a boy who lived a little further off in Richmond Terrace, but who had since July 4th slept at No. 5, where the first of these cases occurred (in January 1887), sickened of the disease. There were thus, during the two years, in this immediate locality five cases of fever in four families, and, without including the washerwomen in Balmoral Road, two attacks

in individuals employed there during the day. The butcher's family, comprising eight persons living on the premises, were unaffected.

In Balmoral Road a small grouping of cases has likewise been spoken of. It is situated on the other side of the main street (Victoria Road), and extends from 100 to 200 yards from the slaughter-house. Of the 20 houses on the south side of the street, four have been infected by typhoid fever during the last two years—one in December 1886, one in January 1887 (the case of the washerwoman above referred to), one in May 1887, and one in November 1888. I am informed by a medical man who practises largely in the locality that this row of dwellings has been a favourite habitat of other infectious diseases.

In Victoria Terrace, Egerton Street, two adjacent houses were infected in 1887, and one of them was again the seat of the disease in 1888. They are situated some 150 yards from the slaughter-house.

No doubt this district of New Brighton is somewhat more than usually subject to the importation of disease, but so far as inquiries showed, in only one of the list of cases given above was reasonable cause found for concluding that the disease had been imported from without. The tendency to grouping too observed above, and to the recurrence of the disease in the same locality in successive years, implies some local continuing cause.

There is no sufficient evidence therefore for regarding the slaughter-house as the origin of the fever prevalence. It is not an accurate representation of the facts to say that "the neighbourhood was free from "fever previous to slaughtering, since then it has not been clear except "from October 1887 to June 1888, when slaughtering was not allowed." Of any indirect and subsidiary agency it is much more difficult to speak. Undoubtedly the slaughter-house has contributed with several other conditions to vitiate the atmosphere of its immediate vicinity, and we have abundant evidence that the contagia are apt to thrive in media polluted by decomposing animal matter.

The Water Supply of New Brighton is that common to the whole district, and is pumped from wells in the New Red Sandstone. The supply is on the constant system, but during the autumn of 1888, owing to the relaying of the mains, considerable intermission in the service to the streets of New Brighton was necessary. There appears no ground for suspecting that the fever prevalence was related to the water supply.

As to the *Milk Supply* also the facts afforded no evidence of extension of fever by that means.

Sewerage and Drainage.—The greater part of New Brighton drains to a sewer which passes down Victoria Road (the main street) to an outlet into the sea at low-water mark. Several of the branches of this sewer are ventilated by open man-holes, and pipe ventilators to private drains are in other places improperly relied upon as a means of sewer ventilation, but in the sewer itself no opening for this purpose is provided in the last 600 yards at least of its course along the Victoria Road. [The Surveyor tells me that originally there was an objection to the provision of openings here, owing to the amount of loose sand of which the surface of the ground is composed, but that, now that the land is mostly built upon, this difficulty is removed.] The defect is probably the more serious as twice every day the sewer for a short distance at least is tide-locked. Certain of the branch sewers are likewise unventilated. This is the case with the one draining the south side of Balmoral Road, where, as I have said, fever has made its appearance at

intervals during the last two years; the private drains here are ventilated only by rain-water spouts, they are connected directly with the public sewers, and I heard several complaints of the escape of foul air from yard gullies and other drain openings.

Although the Authority have done much of late years to remedy defects of private drainage, the conditions are still in a large number of instances exceedingly unsatisfactory. Drains are commonly carried beneath the floors of dwellings, and without the special precautions necessary in such cases; the disconnecting trap in the course of the external private drain is only exceptionally provided, and, though kitchen slop-stone pipes have been "disconnected," gullies, having unbroken communication with the drain, and so with the sewer, often exist in cellars. I was led to visit certain "lock-up" shops, consisting chiefly of refreshment rooms and the like on the Parade, by finding that in two cases the families of the occupiers, living elsewhere, had suffered from fever; and here, in places much frequented by excursionists and other chance visitors, the condition of the private drainage was such as to cause a serious nuisance, well calculated to spread such a disease as typhoid fever. In one an excessively foul water-closet and lavatory were situated in a dark and wholly unventilated recess between two eating rooms, and I was told that in several other cases the structural arrangement was the same.

The appearance of typhoid fever at New Brighton has been found so constantly associated with specially grave defects of drainage, as to create a strong suspicion that this condition has been the cause of mischief. It has been objected that the disease has recurred after defects have been remedied, but as to this, even if the remedy had always beeh thorough, which is very far from being the case, it must not be forgotten that the typhoid-fever poison may make its home, there is every reason to believe, in the soil. That poison, once finding its way by leaky drains or otherwise into the soil, is likely under favourable circumstances to reassert itself.

In this relation, the history of the cases in the immediate vicinity of the slaughter-house is as follows: When fever broke out in January 1887, at No. 5, Richmond Terrace, it was found that the sewer in the back street was defective and leaky and partially blocked by deposit. The drains, however, of the two houses, Nos. 5 and 6, were found not to discharge into this sewer, but to be carried beneath the houses, ostensibly to another sewer in the front street, but, in reality, owing to defective connexion, to a sort of cesspool that the discharge had made for itself in the soil. These defects were remedied about February 1887; and, later, the privy middens with which the houses had up to that time been provided were converted into water-closets. The Surveyor gives the date of the completion of this latter work, in which of course much polluted soil had to be disturbed, as August 2nd; and it was about August 14th that fever was found to have invaded the house, No. 6. Another case of fever, it may be remembered, occurred in the following year (July 28th, 1888), in the person of a boy who had been sleeping at No. 5 of this terrace: other cases had just previously occurred in the neighbourhood, one of these earlier sufferers being a relative of the boy whose infection is now under notice.

The cases referred to, the remaining ones of this group of cases, were three in number. Mrs. Dolan, living next door to the butcher's premises, sickened on July 2nd; a lad employed at Mr. Snow's shop next door (two doors from the butcher's) sickened on the same day, and another lad employed at the same place a little later. Mr. Dolan states that an extremely offensive odour had been noticed just before his wife's

seizure, owing to the pumping out of the underground cistern, already referred to, in the butcher's yard. This offensiveness was not apparent at the time of my visit, though the situation of the cistern was such as to admit of its contamination from the yard surface. The circumstances of the drainage seemed to me, however, to afford more ground for suspicion. One drain is made to serve the purposes of both the houses in question (those of Mr. Dolan and Mr. Snow). It is carried beneath the basement floor of both houses to its connexion with the unventilated sewer in Victoria Road. The special precautions in construction, proper in such cases, have not been used; and a direct connexion with the drain exists, by means of a gully grating, in the cellar of each house. Twice during recent years this drain has caused obvious trouble by stoppage and leakage on Mr. Snow's premises. The coincident appearance of fever and the common drainage defect, taken in conjunction with the experience elsewhere in this locality, would seem to possess significance.

General Sanitary Administration.—The district has obviously suffered much in its sanitary circumstances from the slovenly operations of the "speculative builder," and from past neglect of proper supervision by the Sanitary Authority. Of late years, however, there has been a decided change in this respect, and the Sanitary Authority, aided now by an energetic Medical Officer of Health and Surveyor, have done much to remedy the evils that had arisen. Thus, during the last six years, over 1,200 cases of direct connexion between the interior of houses and the sewers have been dealt with. In a number of instances water-closets have been removed from dark ill-ventilated corners in the interior of houses to the outer wall; in nearly 400 cases soil-pipes have been ventilated; in 846 cases offensive privies have been converted into water-closets; in 400 cases water-closets, previously imperfectly supplied, have been provided with flushing cisterns. In 242 cases the surfaces of yards, passages, &c., have been flagged or otherwise made good. In addition to these private improvements public works of much value have been accomplished. The roads are now, with few exceptions, it is said, and so far as I myself saw, in good condition. With trifling exception the whole district is sewered, and many of the sewers, heretofore of most defective construction, have been relaid. Their means of ventilation, although still in many cases altogether inadequate, have been augmented; hundreds of pits that have been found in the invert of the old sewers, causing much deposit and stagnation, have been removed; and a more satisfactory method of flushing has been partially introduced. For combating outbreaks of infectious disease a small isolation hospital, with necessary adjuncts, has recently been erected, and has already done good service. The disinfection of infected houses, &c., is carried out under the supervision of the medical officer of health.

In the scavenging of the district an alteration in the present methods is needed. Even when water-closets are substituted for the old privy middens, the ash-pit of the latter is retained, and removal of the refuse only takes place at monthly intervals. The improper accumulation of stable manure about dwellings has already been referred to.

Board's Recommendations.

The chief points to which the attention of the Authority is still required are the following:—

1. Each sewer should be ventilated efficiently, and independently of private drains.

2. In addition to the improvements in private drainage already set on foot, further attention should be given to drains that are carried beneath the basement floor of dwellings, and to direct drain connexions in the cellars of houses.

3. All large ashpits causing nuisance should be replaced by small bins or moveable receptacles; and a weekly, or bi-weekly, or daily removal of refuse (according to the nature of the locality) should be provided for.

4. The removal of manure and trade refuse should be placed under more strict regulations.

5. Nuisances arising from the improper keeping of animals should be dealt with.

6. Nuisances arising from want of the proper surface paving and drainage of house yards should be abated.

7. The slaughter-house byelaws should be strictly enforced.

8. For the protection of the district against epidemic disease the Authority should endeavour to secure that prompt information of all cases of infectious disease be supplied to the Medical Officer of Health.

ADDENDA.

Fever Prevalence in the Wallasey U.S.D.

Deaths.

—	1884.		1885.		1886.		1887.		1888.	
	Typhoid.	"Fever" (other or doubtful sorts).	Typhoid.	"Fever."	Typhoid.	"Fever."	Typhoid.	"Fever."	Typhoid.	"Fever."
Liscard (with New Brighton)	3	—	—	—	1	—	2	2	6	—
Seacombe cum Poulton -	3	—	3	—	2	—	8	1	3	—
Wallasey - - -	—	1	—	—	1	—	—	—	—	—

Available Returns of Sickness.

—	1884.		1885.		1886.		1887.		1888.	
	Typhoid.	"Fever."	Typhoid.	"Fever."	Typhoid.	"Fever."	Typhoid.	"Fever."	Typhoid.	"Fever."
Liscard (with New Brighton)	7	6	5	1	1	6	8	—	20	—
Seacombe cum Poulton -	2	15	9	6	13	12	24	—	15	—
Wallasey - - -	—	1	—	—	4	1	2	—	1	—

Extract from Prefatory Memorandum to Model Byelaws (Series VI.) issued by the Local Government Board for the use of Urban Sanitary Authorities, 25th July 1877.

"But as regards premises for which, under section 126, the licence of the Sanitary Authority will be required, the Board have been advised that, in the exercise of the discretionary power of licensing which has been conferred upon the Sanitary Authority, the following rules as to site and structure should influence their decision upon each application for a licence:

1. The premises to be erected, or to be used and occupied as a slaughter-house, should not be within 100 feet of any dwelling-house;

and the site should be such as to admit of free ventilation by direct communication with the external air on two sides at least of the slaughter-house.

2. Lairs for cattle in connexion with the slaughter-house should not be within 100 feet of a dwelling-house.

3. The slaughter-house should not in any part be below the surface of the adjoining ground.

4. The approach to the slaughter-house should not be on an incline of more than one in four, and should not be through any dwelling-house or shop.

5. No room or loft should be constructed over the slaughter-house.

6. The slaughter-house should be provided with an adequate tank or other proper receptacle for water, so placed that the bottom shall not be less than six feet above the level of the floor of the slaughter-house.

7. The slaughter-house should be provided with means of thorough ventilation.

8. The slaughter-house should be well paved with asphalte or concrete, and laid with proper slope and channel towards a gully, which should be properly trapped and covered with a grating, the bars of which should be not more than three-eighths of an inch apart.

Provision for the effectual drainage of the slaughter-house should also be made.

9. The surface of the walls in the interior of the slaughter-house should be covered with hard, smooth, impervious material, to a sufficient height.

10. No watercloset, privy, or cesspool should be constructed within the slaughter-house.

There should be no direct communication between the slaughter-house and any stable, watercloset, privy, or cesspool.

11. Every lair for cattle in connexion with the slaughter-house should be properly paved, drained, and ventilated.

No habitable room should be constructed over any lair."

No. 17.

REPORT on a widespread EPIDEMIC of SCARLATINA in the URBAN SANITARY DISTRICT of LOWER BRIXHAM (DEVONSHIRE), and upon the GENERAL SANITARY CONDITION of the TOWN; by DR. BLAXALL.

THE parish of Brixham, situated on the south side of Torbay, contains the small towns of Higher and Lower Brixham, which so far as continuity of streets is concerned might be regarded as one town, but for "sanitary purposes" the two parts of the parish are under separate jurisdiction, Higher Brixham being under the Totnes Rural Sanitary Authority, and Lower Brixham under a local board constituted in 1862.

Lower Brixham, with which this report is concerned, covers an area of some 399 acres, situated partly at the shore end of a deep narrow valley that extends in a south-westerly direction from the sea up to Churston, and partly in a second valley that goes southward up to Higher Brixham, the two valleys intersecting each other about the middle of the town of Lower Brixham. The hills at the shore end of the Churston valley rise to an elevation of 160 feet above sea-level, and their summits are about 480 yards apart. At the low level near the quays the dwellings stand thickly packed in courts, alleys, narrow lanes, or streets, but on the slopes of the hills they are built in zig-zag streets, tier upon tier, until the summits are reached. Two small streams enter the town, one from each valley. The geological formation is limestone, the rock frequently cropping up to the surface.

Lower Brixham is the principal seat of the Torbay fisheries, and is provided with artificial harbours and quays partially protected from the force of the sea by a breakwater. It possesses numerous trawlers and other fishing boats which bring their cargoes here, and the landing of the fish on the quays, together with the selling, cleansing, packing, and despatching of it presents a strikingly animated scene.

In 1881 the population was enumerated at 5,366, and is now estimated to have increased to some 5,800 or 6,000 persons. Nearly all the men and growing lads are engaged in the fishing trade.

Upon arrival at Brixham I called upon the chairman of the Authority, and put myself in communication with the several officers, medical practitioners, and head teachers of the various schools. The medical practitioners courteously supplied me with lists of cases of scarlatina that had come under their notice, and the teachers with lists of children who left school through sickness during the two months that intervened between the time of re-opening of the schools on the 3rd of September after the summer holidays, and the time of closing of them again on the 2nd of November on account of the prevalence of scarlatina. The returns showed that a very large number of families had been invaded with scarlatina, and that scarcely any part of the town had altogether escaped.

I propose to report, first, on the sanitary conditions under which the people live.

SANITARY CIRCUMSTANCES.

Sewerage and Drainage.—Some years ago the Authority carried out a system of sewerage, laying down Jenning's patent glazed pipes of

various calibre in the several streets, and connecting them with the main sewer, which is constructed of brick, egg-shaped, and measures 5 feet by 3 feet 4 inches. This sewer receives the water of the two streams already mentioned, at their junction in the centre of the town near the Local Board Office, and is then led along the back of Middle Street, past the gasworks, to a place outside the quay on the sea shore, where it discharges above low-water mark, the outlet being exposed for two hours or so when the tide is out. The outlet is not provided with a flap-valve, hence the wind coming from certain quarters blows direct up the sewers. As the tide rises the water also gains an entrance, flowing up the sewer to the low-lying parts of thie town, and so damming back the sewage. Further, during heavy ranfall the storm water courses down the steep streets in considerable volume, and rushes into the sewers with great velocity, causing flooding of the lower parts of the town, and to remedy this evil relief sewers have recently been laid to carry off part of the storm water. I am informed that the joints of the sewers as originally laid were secured with clay, and became so leaky as to necessitate the relaying of certain of the sewers: also that one of the sewers, that in Fore Street, had to be taken up on account of faulty gradient, when the Authority substituted a new sewer laid down Fore Street and Bank Lane to the main sewer.

King Street sewer is provided with a flushing tank with a discharge the full bore of the sewer. Other sewers are flushed by means of hoses attached to hydrants, but these do not effectually fulfil the purpose, as the volume of water so discharged into the sewers is small, and hitherto this flushing could only be carried on for sewers below a certain elevation, as the town water supply would not reach the top of the town. The ventilation of tide-locked sewers is always a matter of considerable importance, but it has been almost altogether neglected here, for apparently only three 4-inch shafts have been provided for the purpose. True, certain of the rain-water pipes pass to the sewers; these, however, add but little to the efficiency of the ventilation, for when most needed to relieve air pressure during the times of rainfall, they are employed in carrying water into the sewers. The street grids are as a rule trapped, but the traps are often forced, as evidenced by the complaints I received of stinks emanating from them both at the high and low levels. Where grids are untrapped, as at Browses Court (low level) and Sea View (high level), I noticed quite a volume of foul air escaping, much to the discomfort of residents in the neighbourhood. The faulty character of the house drainage is also an element of considerable danger to health, the sink pipes and drains very commonly going direct into the sewers, thus affording a passage for the conveyance of the sewer air into the dwellings. Complaints of intolerable stinks in houses were general. Bell traps are much used, and were not infrequently found off or broken. At places I found drain-inlets untrapped, and at Sea View, behind Braddick's house, I observed an exaggerated nuisance from this condition.

I am told that improvements have been made in house drainage by laying down glazed pipes where the construction of drains has been found faulty; but it would seem likely that drains of defective construction still exist. Thus in a court leading from Higher Street I observed a closet drain, apparently simply a channel in the rock covered over with tiles, causing considerable nuisance to the occupants of a cottage, owing to the tiles being broken.

Closets.—The closet accommodation of the town is of a most unsatisfactory character. Where closets are placed in suitable positions in

yards they are seldom provided with water for flushing, and consequent blockage of drains with accumulated excrement is frequent. But a greater evil exists in the most unseemly positions in which the closet pans are occasionally placed, sometimes in the window sill of a living room where the family live, cook, and take their meals, or in a pantry where food is kept, or in a bed-room, or again under the staircase, in the cellar or washhouse, and so forth; these make-shift closets being unprovided with water for flushing and being often without means of air or light. Many dwellings have no closet accommodation at all, and have neither available ground space outside nor any suitable position within the dwelling to admit of closet provision. Here the families are supposed to keep the excrement in vessels till it is fetched away. This is professedly done by means of metal carts sent round daily to collect house refuse. But in some instances the excrement is thrown on to the street grids, creating revolting nuisance. A few cess-pit privies came under observation, which might at little cost be converted into pail closets.

Water Supply.—In 1871 the Authority provided the district with a water supply derived from springs situated in Higher Brixham, in the immediate vicinity of the celebrated spring known as "Lady Well," which for many years was remarkable for the ebbing and flowing of the water at regular intervals, until some cutting work carried out in the rock put a stop to this phenomenon. The water is now derived from two reservoirs, said to be capable of holding 419,958 gallons, and fed by pipes driven underground. From these reservoirs the water is led in iron pipes to the town, and there distributed to dwellings and stand pipes situated at such levels as the water will reach, the source not being sufficiently high to enable the water to be carried to the highest parts of the town. Measures have recently been taken to improve the supply to higher levels by providing an iron reservoir, into which water will be pumped up, and thence distributed to the town by gravitation. The supply is on the continuous system, and is said to be plentiful and wholesome. I could see no reason to suspect the quality of the water at its source, but I found evidence of exposure to pollution at four places in the course of its distribution, where water-pipes were in direct communication with closet-pans. Again, in some dwellings where there are closet-cisterns, water is drawn from these nominally for lavatory purposes, but probably also for drinking. Dwellings situated above the level supplied by town water, and some few of those situated at lower levels, are at present dependent upon rain-water collected from the roofs in tanks, and this is used for drinking as well as for domestic purposes. This water was often complained of as being thick and black, which is likely enough to be the case, considering the extent to which the roofs of town dwellings are exposed to smoke deposit. Some of the overflow pipes from rain-water tanks apparently went direct to drains. Some 30 to 40 families derive their drinking water from a private source belonging to Mr. Fogwell. The water is collected in a small reservoir situated in his garden on the New Road, Churston Valley, by means of pipes which are said to bring water down from two wells situated above the level of the reservoir; the supply being conveyed from the reservoir in pipes to the several dwellings. A small stream runs close alongside the reservoir, and if polluted by sewage, as it is said to be, cannot fail to endanger the purity of this water supply. The surface of the water in the reservoir was covered with a thick green scum, giving it a repugnant appearance, and quite explaining the general complaints I received of the quantity of insects the water contained. In three or four places I found families using water derived from wells sunk in dangerous proximity to drains

and sewers. The "Greenwood Well," on the road to Higher Brixham, is much used by the people in its vicinity. This water appears at the surface close to the stream which passes from Higher to Lower Brixham, and is said to be polluted with drainage, &c.

House Accommodation.—Many comfortable tidy-looking and cleanly dwellings came under notice, but others, notably those already referred to as closely packed together in courts and alleys, stand back-to-back, and besides being rendered unwholesome by the escape into them of sewer-air from closet-pans or drains, they are in a dirty, neglected state. Some few are dilapidated, whilst others suffer from dampness. Certain yards are well paved with concrete or cement, but others with pebbles, the interstices between which retain the wet. And further, these yards and other confined spaces around the dwellings are polluted by excremental matters, fish offal, and other refuse thrown on the sewer gratings, &c. There are no common lodging-houses in this district.

Refuse Removal.—Fixed receptacles for fish refuse are provided on the quay, and it is said that they are systematically cleared out, and the quays washed down after fish sales. The Authority carry out street sweeping and scavenging, but the configuration of the town, together with the domestic habits which I have described, throw difficulties in the way of the work being effectually done. House refuse is removed by contract daily in covered metal carts provided for the purpose.

There are two slaughter-houses in the district, both removed from dwellings, but they are not registered, nor, in regard to construction and management, can they be considered satisfactory. Just outside the one at Ranscombe I observed a large accumulation of blood, garbage, and manure covering an area of some 30 feet by 15 feet. Pigs and other animals are not generally kept, but in the few instances met with they were in unwholesome relation to dwellings.

The Authority possess byelaws of old date (1865) relating to the prevention of nuisances, cleansing of foot-paths, regulation of slaughter-houses, common lodging-houses, and construction of new streets, but they have not been enforced.

There are several milk shops in the town, but the Act which came into operation in 1886 for the registering of dairies, &c., has been disregarded, for milk shops have neither been registered nor inspected. So far as I could learn there are no cows kept in the district, but all the milk is brought in from the surrounding country, and is said to be sold within an hour or two of its arrival. When kept it usually stands in the shop. In two or three instances I saw milk for sale standing in the near vicinity of drain inlets.

Isolation of Infection.—The Authority have made no infectious hospital provision, although the Board have frequently brought the importance of the subject under their notice, nor have they provided means for disinfecting infected articles of clothing, bedding, &c.

Scarlatina Prevalence.

Scarlatina was present in and around this district some months previous to its assuming epidemic proportions in September last, one death having been registered from scarlatina as far back as April, as occurring in a farm-house near Higher Brixham, the disease continuing to hang about that house for some time. Shortly afterwards a mild case occurred in a child residing in Lower Brixham. The precise date of this attack is not known, as the case escaped detection until the child died of dropsy in July. Another case followed in Higher Brixham in the beginning of July in a family who had recently removed here from

the vicinity of the infected farm-house. On the 10th of July the Medical Officer of Health reported to the Sanitary Authority as follows:—"The present sanitary condition of the town is very good, with "the exception of a slight outbreak of scarlatina of a mild character; no "other zymotic disease has been brought under my notice."

About the third or fourth week in July there was a fresh introduction of the disease into Lower Brixham by the arrival of an infected person from Plymouth, and a little later on (end of July) a further introduction by an infected family arriving from South Wales; subsequent spread of the disease from this family was distinctly traced to three separate families living in their neighbourhood. I found a popular disposition prevailing to assign the origin of the epidemic to this last introduction, but it took place, as has been said, only after scarlatina had been hanging about the district for some months.

Altogether I made inquiry and inspection of some 300 dwellings, and found that out of these 180 had been invaded with scarlatina, 8 prior to the opening of the schools on the 3rd September after the summer holidays, and 172 subsequently. In all there were 351 cases and 43 deaths up to the end of December. The disease is still present in the town.* The infected houses are scattered about the district; some standing at high and some at low levels, and being usually in groups of from three to six or more. For example, (1) Middle Street, where seven or eight dwellings standing together were invaded; (2) Cumbers Court, consisting of three dwellings all invaded; (3) Mount Pleasant Road, seven or eight infected dwellings standing in a terrace; and so in other places.

There was no evidence to throw suspicion upon sewer air or other excremental conditions within or around dwellings, as having been the means of spreading the fever; nor did milk or any other article of diet appear to have been concerned in its spread, but the whole inquiry has gone to show that this spread was effected by personal intercommunication between infected and healthy, the schools playing a prominent part in the dissemination.

There are five Board or National schools in Lower Brixham, and two in Higher Brixham. They were all closed on August 3rd for the summer holidays, and re-opened on September 3rd. This re-opening of the schools was followed by a marked and continued increase in the spread of the disease until November 3rd, when, by advice of the Medical Officer of Health, they were again closed.

Besides the above there were the Sunday and certain "Dames' Schools," which uudoubtedly were factors in spreading the disease.

The subjoined Tables are prepared to show (A.) the total number of families invaded and the dates at which they became invaded, with the number of first attacks in families that occurred in school-going children, side by side with the number of such attacks in non-school-going children and others; and (B.) the total number of cases and deaths in children of each year of age up to 15 years.

It will be seen, by reference to Table A, that prior to the 1st of September (and so prior to the opening of the schools on September 3rd) eight families were invaded; that there were 25 fresh attacks during the month of Stptember and 77 during October. Then there was observed a decline in the first week of November, followed by a certain increase in the second week ended November 10th. This appeared to be due, as will be presently explained, to a large gathering of people for a public ceremony. From November 10th there was a notable diminution in the weekly number of families attacked, and this

* Report bears date January 1889.

TABLE A.

No. of Families invaded with Scarlatina.		Number of First Attacks amongst		Weekly Sequence of First Attacks in Families from the 1st September to the 29th December.															Number of First Cases in which the precise Date of Attack is not known.	Total.
				Week ending																
				September.				October.				November.				December.				
Before the 1st of September.	After the 1st of September.	School Children.	Other Children and Persons.	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29		
8	172	87	85	5	4	4	12	8	17	25	27	13	19	4	4	5	3	4	2	9	7	172

TABLE B.

Number of Cases and Deaths at the given Yearly Ages.																												Total Cases.	Total Deaths.
0–1.		1–2.		2–3.		3–4.		4–5.		5–6.		6–7.		7–8.		8–9.		9–10.		10–11.		11–12.		12–13.		13–14.		14–15.		15 and over.			
Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.		
14	3	28	7	41	10	64	6	31	3	34	4	23	4	22	2	19	1	17	1	13	1	7	—	10	—	1	—	1	—	26	1	351	43

reached a mininum (2) in the last week but one of December, rising again to nine families freshly invaded during the last week of the year. This last rise possibly finds explanation in the greater intercommunication between families and friends at Christmas-tide.

During the nine weeks (September 3rd to November 2nd) that the schools were open, 115 families were invaded, against 50 in the succeeding eight weeks, when they were closed, this latter period including the exceptionally high number in the week ending the 10th November above referred to.

Within three days of the re-opening of the schools on September 3rd, three children returned home from school ill with scarlatina. It follows that they had attended there when incubating the disease, and they were in all probability the means of introducing the disease into the schools. From this time scarlatina continued to spread amongst school-going children; and 87 persons had to tell the tale of the first attacks in their families being in the persons of children who "returned from school ill" with the complaint.

Evidence went to show that the infection was kept up in the schools by children from infected families continuing to go to school up to the time of being themselves attacked, or, until the schools were closed; and again by children convalescing from the disease returning to school when in the desquamating stage.

In this way the disease spread from infected to healthy children in the schools, and was carried by them to their respective homes, each newly-infected child and family becoming in turn a fresh centre of infection to their immediate neighbours and others with whom they came in contact. Thus there is no difficulty in accounting for the wide-spread nature of the epidemic, as well as for the scattered *groups* of dwellings that were invaded, as already mentioned. I witnessed many examples of reckless exposure of infected persons. In one house three members of the family suffering from scarlatina were seated in the same room with a lad who, having just come in for his dinner, was about to return to his shop where he would serve customers. In a second house a neighbour's child had come in to play with a little one convalescing from the disease; while in several other dwellings I saw infected children occupying the general living room frequented by neighbours and others. Again, eye-witnesses spoke of children in the streets peeling the skin off their fingers to see who could get the largest flake. I heard also of the infected dead being frequently kept in the houses from three to seven days awaiting burial, the children and neighbours in some instances going in to view the body, and attending the funerals in large numbers. I met with repeated instances in which attacks followed within a few days of such exposure to infection, notably so one case in which a child was taken to see the dead body of its little friend, and three or four days afterwards was attacked with scarlatina, and died within the fortnight; subsequently the three remaining children suffered from scarlatina, and the mother from sore-throat, while the father suffered from erysipelas.

With regard to the public ceremony to which the increase of cases during the week ended the 10th of November has been referred, this took place on November 5th, on the occasion of laying a memorial stone on the spot where the Prince of Orange landed, and a large concourse of persons was thus brought together. Many persons stated that the first time of their children going out after their illness was to witness this ceremony; others that their children were well when they went to see the stone laid; but four or five days afterwards they were "down with the fever." There can be little doubt that this assembling

of infected and healthy persons was instrumental in spreading the disease.

A certain predisposition to contract the disease seemed apparent in several families, it being no unusual thing to find near relatives attacked with the disease, while others equally exposed escaped the infection.

Further, it transpired that some persons and families invaded during the present epidemic had suffered from the disease four years ago when scarlatina was prevailing in Brixham. One family, in which five cases and three deaths have occurred during the recent epidemic, had three cases and one death on the former occasion, the two survivors being now attacked for the second time.

Many other instances of second attacks came under observation during this inquiry.

Reference to Tables A. and B. shows a total of 180 families invaded, with 351 cases and 43 deaths. Multiple cases of definite scarlatina, from two to six in number, were observed in 94 of the families, to say nothing of cases of suspicious sorethroat. But medical practitioners spoke of bad and troublesome sorethroats as being of frequent occurrence in families that had been invaded by eruptive scarlatina; so probably there was more disease of a scarlatinal nature in the district than is expressed by the above figures.

Multiple deaths, too, took place in some invaded families; one family losing three, and two others losing two of their members. As regards the fatality of the disease among persons attacked, it is to be recorded that in the closely packed and generally unwholesome dwellings of the lower parts of the town, an excessive mortality took place. No less than 11 out of 48 known cases were fatal in the houses of these localities, or nearly one death to three recoveries; whereas in the remainder of the district, the deaths were 32 out of 303 known attacks, or more than eight recoveries to each death.

The data of the foregoing Table B. as to attacks in this district are so far complete as to yield evidence of some interest respecting the age-distribution of attacks. In successive years of life, up to four years of age, it is found that the children had an increasing liability to attack; and in subsequent years a diminishing liability. But in this connexion the previous prevalence of scarlatina four years ago has to be remembered. The liability to death after attack did not quite follow the same rule. Children under three died in the proportion of one-fourth of the attacks; but in the fourth year of life (the period of maximum susceptibility to attack) the disease was much less fatal, the deaths numbering only one-tenth of the attacks.

It would appear plain from the foregoing history that at one time it was within the ability of the Sanitary Authority to prevent the epidemic. There was no sudden outbreak affecting simultaneously any number of families, but for some weeks there were only a few cases which might have been isolated, if a place for their reception had been at hand; and such isolation with efficient measures of disinfection of clothing and bedding would in all probability have stayed the further spread of the disease, and have been the means of saving some hundreds of cases of sickness, and some dozens of lives. The Authority, however, were not in a position to carry out such isolation or disinfection. They had no isolation hospital, nor did they attempt to improvise one to meet the emergency. They were at no pains to prevent the exposure of infected persons and things, or even to warn people against that free intercommunication which they knew to be going on between infected and healthy. The Medical Officer of Health, beyond advising the closing of the schools at the beginning of November (*i.e.*, after the disease had made a firm

lodgment in the town) has done nothing to assist or guide his Authority in this time of urgent need.

The full effects of the evils of this epidemic cannot be estimated by the sickness and mortality above recorded, not to mention the money cost of the sickness, or the impairment of health to survivors:—it will be sufficient to point in addition to the discredit incurred by the town through this epidemic. This has already made itself felt by visitors ceasing to frequent the place, a circumstance of which I received general complaint.

I have already mentioned that scarlatina was not extinct at the end of the year, when my inspection terminated. Further I learned during my inquiry, of measles recently introduced into the town. I accordingly addressed a letter to the Authority, proposing for their adoption such measures to prevent the spread of these diseases as would be available for instant use.

Sanitary Administration.—Mr. Searle, Parochial Medical Officer of the Brixham District (Totnes Union), holds the appointment of Medical Officer of Health at a salary of 20*l.* per annum, no part of which is paid from moneys voted by Parliament.

He has not fulfilled the duties attaching to his office in any such manner as is contemplated by the Public Health Acts and required by the Board's Instructions. He has made no inspection of his district, nor has he advised his Authority as to the adoption of measures necessary to prevent the spread of infectious disease and to remedy unwholesome conditions calculated to exercise a prejudicial influence upon the health of the community. He ascribes this neglect to the terms of his appointment not requiring him to carry out such duties. At the time of my visit he was not receiving returns of mortality in accordance with the Board's memorandum of July 1885:—they were sent to him for a while at irregular intervals, the Authority paying the registrar 1*l.* 1*s.* per annum to supply them, but this payment was stopped a few months since.

Mr. Widdicombe has just recently been appointed Inspector of Nuisances and water bailiff for the urban district, and road surveyor to the whole parish, at the small salary of 60*l.* per annum, partly paid by the Highway Board. Of the 60*l.*, 12*l.* only is allotted in payment of the duties of Inspector of Nuisances. It has been shown that this district stands in special need of strict supervision and close searching out of nuisances. And it remains for the Authority to consider whether they can reasonably expect the work to be satisfactorily done under the present arrangements and for the small salary given.

The Authority have done much good work in paving and lighting the town, as also in providing it with sewerage and water supply and in carrying out measures to improve the same. On the other hand, in their current sanitary administration they have signally failed, as hereinbefore stated, to fulfil the requirements of their own byelaws, and to give effect to the Public Health Act in regard specially to the clauses relating to disease prevention and to nuisances. Such failure would appear to be in part due to their not making proper use of the Medical Officer of Health and Inspector of Nuisances appointed in accordance with the requirements of the Public Health Act to assist them. No doubt they have in some respects great inherited difficulties to contend with in carrying out their duties, owing to the close manner in which dwellings are crowded together in the old parts of the town. But even as to this much might have been done under the advice of a careful Medical Officer of Health, and by the aid of a vigilant Inspector of Nuisances, to improve

the condition under which the people live, to secure efficient ventilation and cleanliness of dwellings, and to insure their precincts being kept in a wholesome condition. I am informed that frequent notices have been posted up warning people not to commit nuisances by throwing filth on the street grids, &c., but in no instance could I learn that legal or other action had been taken to enforce the notice. The excuses alleged were that the "notices were torn down," and the "difficulty of finding the offender," but such difficulties would hardly be pleaded by an Authority in earnest about its sanitary duty. As a riparian authority they have neglected to secure such inspection of vessels as is directed by the Public Health Act (section 110). This inspection is for Brixham a matter of considerable importance, seeing that a very large number of small craft frequent this port.

No. 18.

Dr. Ballard's Report upon an Epidemic Malady prevalent in Middlesbrough and its neighbourhood, the most obvious character of the Disease being Pleuro-pneumonia [Pleuro-pneumonic Fever].

Early in June 1888 a communication from Dr. Malcolmson, the Medical Officer of Health of Middlesbrough, reached the Board, giving information that a serious and very fatal epidemic of pneumonia had for some time been prevailing in that town, that it had attracted public notice, and that it had occasioned some degree of panic. He asked the assistance of the Medical Department in investigating and dealing with it, and I was consequently instructed to visit Middlesbrough in compliance with this request. This instruction was received by the Town Council with satisfaction, and by giving directions to all their officers to afford me all the assistance I needed, and in other ways, they did all in their power to aid and facilitate the inquiry.

Prior to my arrival in Middlesbrough on the 15th June, the majority of the medical practitioners in the town had, at my request (conveyed to them by Dr. Malcolmson), furnished lists of cases of pneumonia that had occurred in their several practices since the previous November, and they subsequently supplemented them by lists of cases that occurred later on. Shortly after my arrival in Middlesbrough, I received information that the malady prevalent there was not confined to that town, but had been prevalent also in some neighbouring local board districts on the south side of the Tees and situated between Middlesbrough and the sea coast, namely, in Ormesby, Normanby, and Eston local board districts. At a later date I received the Board's instructions to include these districts in my inquiry, and consequently obtained from the medical gentlemen practising in these places lists of the cases that had come under their notice. About these lists I shall have something more to say presently.

Up to the time of my inquiry nothing had been done to acquire a knowledge of the pathology of the current disease; no post-mortem examinations had been made. But on my arrival, several of the principal medical men in Middlesbrough and in the neighbouring districts invaded, gave me opportunities of seeing some of their cases, and, whenever it was practicable, obtained for me opportunities of pathological investigation. I had also the very valuable assistance of Dr. Klein in the pathological part of the inquiry (see pp. 314 to 326). I found various notions existing among the medical men who had had charge of cases as to the mode of origin and mode of spread of the epidemic. Some of them were of opinion that it was due to the remarkable character of the season; others to the topographical peculiarities of the town; others that the disease spread through personal communication from the sick to the healthy; others held that it was due to a concurrence of all these causes. One belief held popularly was that it was an infectious disease; another that it was due to the inhalation of dust given off in a certain newly-established process for the manufacture of an agricultural manure out of the basic lining of the converters employed in the making of steel by the Gilchrist-Thomas method. Some of the medical men in Middlesbrough entertained the last-mentioned notion; they thought it might have had something to do with it.

It appeared probable, therefore, that I had before me a task of no little difficulty, and one which the amount of time I could give

to it would hardly enable me to complete to my full satisfaction. And so it turned out:—I do not, after about two months' inquiry on the spot, pretend to have reached the bottom of the whole matter. Nevertheless I hope that, if I have failed in this, I have at any rate succeeded in establishing some points of importance, both as respects the pathology and etiology of the malady, and in indicating the direction in which further inquiry may be usefully pushed.

The interest of the inquiry is by no means confined to Middlesbrough. From time to time the annual reports made by medical officers of health in various parts of the kingdom to their several sanitary authorities have contained notices of localised outbreaks of "epidemic pneumonia," having clinical features (where they are recorded) more or less similar to those observed in the Middlesbrough epidemic; and medical journalism, both British and continental, has from time to time given indications that some malady, liable to be epidemic and apparently communicable from person to person, and of which pneumonia is the chief feature, is by no means uncommon both here and abroad, and that it has attracted the attention of skilled observers, both from a pathological and causative point of view. Curiously enough, while I was at Middlesbrough, I received a letter from Dr. G. Ollive, of Nantes, physician to the Hotel Dieu and professor in the school of medicine there, informing me that a similar epidemic to that I was investigating had been observed in Nantes during the month of June among the workmen at a factory where (as in Middlesbrough) the basic lining of steel converters was broken up for the manufacture of a manure. Dr. Ollive subsequently published a paper upon the subject in the "Gazette Médicale de Nantes," a copy of which he obligingly sent me. To Dr. Ollive's observations, as well as to the published records mentioned above, I shall have occasion to refer at a later period of this report (p. 238). In the meantime I mention them here in order to make clear to the Board that the inquiry I had to pursue was one not only of local, but of national, and indeed of even of more than national, importance. For I have reason to believe that I am here dealing with a malady of a highly fatal nature, the specific character of which has not been hitherto authoritatively recognised, but which, passing under the name of "pneumonia," and so having been confounded with pneumonic attacks of a less dangerous kind, may have been for a longer or shorter time adding materially to the death-rate of this and other countries.

After these introductory remarks, I may proceed, as systematically as the subject will permit, to record the facts which the inquiry has elicited, so far as Middlesbrough and its neighbourhood are concerned, and to draw such inferences as these facts appear to warrant.

Topography of Middlesbrough and the neighbouring Districts.

The town of Middlesbrough is situated in the hollow of a bend of the Tees about seven miles from the sea, at a spot where from a northerly direction it makes a sudden turn to the south-east and east, and where the river is about 700 feet broad before it begins to widen out into its estuary. On the south side of the estuary the valley is wide, and the land for some distance from the shore is flat and marshy; but it then begins to rise to a range of hills, first very gradually and then by a steeper gradient. In this valley lie in succession (see sketch map No. I.) the local board districts of Ormesby, Normanby, and Eston, all within the parliamentary borough of Middlesbrough, and beyond these lie, facing the sea, the towns of Redcar and Coatham (virtually one place).

To face p. 164.

SKETCH MAP Nº I.

SHOWING TOPOGRAPHY OF MIDDLESBOROUGH, AND NEIGHBOURING DISTRICTS.



DARGEFIELD LITH 22 BEDFORD ST COVENT GARDEN. 1828.6/89.

SKETCH MAP Nº II.

BOROUGH OF MIDDLESBOROUGH AND LOC. GOVT DIST. OF NORTH ORMESBY.



DANGERFIELD LITH. 22, BEDFORD ST COVENT GARDEN. 1852

Each of the above-named local board districts extends from the shore of the estuary to some distance up the hills to the south, and so includes a more or less flat part near the river and an elevated part at a distance from it. Each local board district has a border of marsh land near the river; then further south, at the beginning of the rise a small town, and then on the side of the hill a village or villages of a much more rural character. The town in the local board district of Ormesby is called North Ormesby, that in Normanby is called South Bank, and that in Eston is Grange Town. The villages upon the hill sides are severally Ormesby, Normanby, and Eston. The largest of these villages is Eston; the other two are small, and the houses scattered.

The Town and Borough of Middlesbrough.

The town and municipal borough of Middlesbrough extends over an area of 2,731 acres, about one fourth of which is continuously covered with dwelling-houses. The Middlesbrough and Redcar Railway intersects this built-on portion of the borough from east to west. It is important to mention this, because the older part of the town to the north of the railway is thus cut off from the newer part to the south of it, and these two parts of the town have distinguishing features. Of the part at the north cut off by the railway, a large acreage in the angle formed by the river at its bend, *i.e.*, the extreme north-west portion of the borough (see sketch map No. II.) is covered with iron and steel works, which extend in succession along the shore of the river to the boundary of the borough at the north-east. Thus it may be said that, as respects the whole of that part of the borough, which is continuously covered with dwelling-houses, it is embraced everywhere except at the south by this class of industrial establishments. The rest of the borough to the south of the railway contains, in addition to part of the town proper, the considerable village of Linthorpe as well as much agricultural land at its extreme south, and intermediately a handsome and extensive recreation ground, Albert Park, with patches of continuous buildings or groups of streets, which in a few years will be connected with what is at present the town of Middlesbrough. The union workhouse is situated near the village of Linthorpe in this intermediate portion, and is surrounded by agricultural land. It is to be noted that the older part of the town, that part north of the railway, stands upon the sides and summit of a low hill rising from the river brink and the railway to a height of about 40 feet or a little more above low-water mark, in the neighbourhood of the market-place and old town hall. There is no other thickly-populated part of the borough that stands higher than 30 feet above datum, except the village of Linthorpe, which stands at about 40 feet. The lowest populated part of the borough (elevation about 14 feet) is at the north-east end of Marsh Road, the next being between this and 16 feet at a number of comparatively new streets about the gasholders between Marsh Road and the river. The soil over the greater part of the borough is clay to a considerable depth, and it may be said generally that in the old part north of the railway it is sand. But there are exceptions. Thus at the southern part of the borough, about the workhouse and cemetery, the clay is superficial only, at a few feet from the surface it becomes sandy, and lower down the clay and sand are laminated. Again, in the lower parts of the old town, near the river, where at earlier periods there was marsh, the soil is peaty. It must be added that in Durham Street, and in other of the lowest parts north of the railway, and in the neighbourhood of Marsh Road, the roadways have been artificially raised, but not with domestic refuse,

either clay from excavations or slag from the ironworks having been used for the purpose, with macadam and flint at the top.

Before proceeding with my account of the town it is requisite that I should say something as to its history. It is one of the most remarkable towns in the kingdom in respect of the rapidity of its growth during recent years. Up to about 50 years ago Middlesbrough was little more than a village, and up to about the year 1866 the town consisted of the part north of the railway east of what is now Stockton Street, and of a few scattered houses close to the railway on the south. The low part north and south of the storage gasholders has been built comparatively recently. The very much larger part of Middlesbrough south of the railway has been built since 1866 for the accommodation of the large population which swarmed into the town in consequence of the great development of the iron-making industry, and concomitantly enlarged trade of the town.*

This land to the south of the railway constituted what was known as the Middlesbrough Estate, which about 1866 began to be sold off in detail to building speculators. During the earlier succeeding years there was, in consequence of arrangements I need not enter upon, much laxity on the part of the town authorities in respect of the exercise of their control over the open space about houses and the width of streets and back passages; but since a duly qualified surveyor has been in office, these matters have been strictly attended to, and the byelaws of the Town Council in this respect are stated to have been duly observed. Hence it is, that the part immediately adjoining the railway on its south side has all the faults of construction which I shall presently describe as characterising the old town on the north side, while the mass of buildings congregated on the rest of the south side contrasts very favourably with the north side in these and in other respects essential for healthy dwellings. On the whole it may be said with regard to the laying out of streets on the south side (with the exception above mentioned), no serious fault is to be found with their width, the width of their back passages, or the amount of space at their rear. Some of the streets are rather too long without break, but that is about all. On the north side, however, all but the main or principal streets (such as Durham Street, South and North Streets, Stockton Street, East and West Streets, and Lower East Street), that is the streets of small houses, are narrow, and the back passages are also narrow; some of the houses are ill-ventilated or are placed back-to-back or have but little space at rear; and almost universally, in this old part of the town, wide streets and narrow streets alike abound in courts. Some of these courts are very close, ill-ventilated, and unwholesome. The streets north and south of the gasholders are laid out and constructed more after the fashion of the streets on the south side. It is in the northern part of the town that all the common lodging-houses are situated, of which I have a list of 21 furnished to me by the superintendent of police. Some of them are in the narrow and some in the wide principal streets.

Sewerage.—There are two systems of main sewers, one for the north side and the other for the south side of the railway. Both require description. 1. The sewers on the north side have been in existence long before 1866. There are two outfalls, one at Watson's Wharf from which a 3-feet brick sewer is carried up behind Stockton Street, with a fall of $\frac{1}{500}$, and across the railway to Boundary Road on the south side. The other outfall is more to the east at Bolckow Vaughan

* In 1866 the rateable value of the borough was 66,893*l.*; in 1870, 106,699*l.*; in 1880, 214,284*l.*; and in 1887, 225,568*l.*

Works, from which a 4′ 6″ × 3′ brick sewer is carried in a south-westerly direction along Dock Street, where it has a fall of about $\frac{1}{250}$, having first received a branch from Commercial Street (fall $\frac{1}{337}$) and along Bridge Street, where it is much flatter. The two outfalls are protected by good tidal flaps which are reduplicated at some yards above the outlets. Into these two main sewers the streets included within the space thus enclosed have been sewered according to convenience. The houses built upon "The Marsh,"—*i.e.*, the low district north and south of the gasholders, are sewered into the Stockton Street main sewer. The small number of houses existing on the south side prior to 1866 were at first sewered into the Stockton Street main sewer where it crosses the railway: an alteration described below has since been made, but otherwise this system has remained unaltered since its construction. The subsidiary sewers are of all sorts of construction in the older part of the town, but many unsatisfactory ones have been replaced by pipes as occasion has arisen. 2. On the south side, when the Middlesbrough Estate was laid out for building in 1866, a separate scheme for main sewering was adopted, and has been carried out and extended, with necessary modifications as circumstances required to the present time, under the direction of Mr. E. D. Latham, the borough surveyor. It is thus constituted now:—The outfall is by a 5′ iron pipe into the river at the extreme eastern end of the borough, about opposite Cargo Fleet Railway Station, where there are requisite arrangements for shutting out tidal influx by means of a tidal flap and penstock. From this spot there is an intercepting "storage" sewer which follows the course of the railway westward to about opposite the Newport Ironworks near the western extremity of the newer part of the town. It has no great fall. It picks up in its course the subsidiary sewers on the south side which originally ran into the Stockton Street sewer: these subsidiary sewers themselves were not reconstructed but were left with all their original faults. But Mr. Latham found that he could utilise the old Stockton Street and Bridge Street sewers on the north side as storm overflows for the new "storage sewer," and he did so by connexions at Boundary Road (West Bridge) and across the railway from near the Exchange to Bridge Street. It may be important to note here that in this way an air communication was established between the two systems of sewers. As a main sewer provision for Linthorpe and the newer portion of the borough to the south, a "branch storage sewer" was carried from the intercepting "storage sewer" above described to the end of the built-on part of the Marton Road, with a fall of $\frac{1}{1500}$. At this point it ceases to be a "storage sewer" and, where at this spot it receives the sewer from Linthorpe, there is a sudden fall from the latter (a cataract of some feet). From this Linthorpe sewer at a point near the Albert Park an overflow sewer has been constructed to the river near the Newport landing. The subsidiary sewers are, with an exception to be stated below, of duly socketted pipes carried up alternate streets, and from these branch sewers pass up the "back streets" (or back passages at the rear of domestic yards) to receive the drainage from domestic yards and premises. During the early years of construction of the south side (when, as stated before, the town authorities exercised but a lax control) these subsidiary sewers were badly constructed, some indeed with pipes, but many with what are termed "segmental tiles" put together without cement or mortar and therefore pervious. They easily became choked up and from time to time as they became obviously inefficient they have been replaced by pipes. But many such branch sewers still exist in the part bounded by the Boundary Road, Newport Road, and railway.

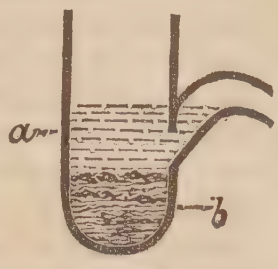
Man-holes.—1. In the *old* northern part of the town the borough surveyor says he knows of about 50 which have hitherto been regarded as the property of the sanitary authority, the Town Council of Middlesbrough. They are of bad construction, being all provided at the bottom with a catch-pit sunk 2′ 6″ or 3′ below the invert of the sewer. The arrangement is shown in vertical section upon Plan 1 (Addendum). I chanced in the course of my inquiry to meet with others in "back streets," and the surveyor tells me there are plenty of such in all parts, how many and where exactly situated he cannot tell, since the sanitary authority has hitherto not regarded these others as their property and only dealt with them under the Public Health Act, where obvious nuisance arose from their neglect. Such man-holes still exist also in that part of the south side which formerly was connected with the Stockton Street sewer. Wherever they exist, these cesspits (for they are virtually such) become after a time filled with deposit of filth, and where the man-holes have openings in the sewer for ventilation (which is only in a few instances, most of them having closely covered doors) must necessarily foul the atmosphere about them; and this it is to be observed is liable to occur in the most densely built-on and most densely populated part of the town. The catch pits which the Town Council have regarded as their property, have been emptied by their workmen at intervals of about a month, but those which they have regarded as private property took their chance of being cleaned until they became such obvious nuisances that they could be left alone no longer. 2. In the *new* southern part of the town there are no such catch-pits either in the main or subsidiary sewers; the bottoms of the man-holes are flush with the inverts.

Ventilation of Sewers.—1. No means of ventilation were provided when the sewers in the *older* part of the town were constructed, the man-holes at that time being all covered and metalled over; but some years ago the present town surveyor constructed at the old town hall, where, at the highest point of the district, there was a convergence of main sewers, a 12-inch ventilating shaft with an "extractor" at the summit, and he carried it to a height of about 60 feet. He says that he has ascertained that there is always an up draught here; but it is unlikely that the ventilator operates over any considerable area. 2. Throughout the new system on the south side of the railway ventilation has been provided by open gratings at the man-holes both of the main and of intercepting sewers. Complaints have from time to time been made of bad smells from some of these, and when this has been the case either an arrangement of trays containing crude carbolic acid has been introduced, *e.g.*, at Linthorpe and in the Coventry Road, which arrangement necessarily impedes ventilation to some extent; or a shaft provided with an extractor at the summit has been carried from the sewer near to the objectionable man-hole up the side of some neighbouring house. Several such shafts have been put up in the Marton Road, and are said to act efficiently, establishing a down draught at neighbouring man-holes. In addition three of these sewers have been connected with furnace chimneys.

Flushing.—The main and subsidiary sewers are satisfactorily flushed at intervals, but the branches in the "back streets" are not flushed, since the Corporation has not regarded them as the property of the sanitary authority.

Domestic Drainage.—For the most part, where there are sinks within dwellings, the pipe is cut off outside so as to discharge upon the surface over or near a trapped gully in the yard at the rear. In the more recently built parts this is effected in a satisfactory manner, the liquid being conducted to a gully at some feet distance; in less recently built

parts the gully referred to is often close beneath the opening of the pipe, so that any foul air proceeding from it is liable to be drawn up through the pipe into the dwelling. But in the older parts of the town the sink pipe is commonly not thus cut off, but is carried underground to discharge into the gully itself beneath its grated opening. An example of this is seen in Plan 4, *a* and *b*. The accompanying woodcut exhibits the sort of gully trap in universal use throughout the borough; it is observable that it is provided with a receiver in which filth deposits and becomes collected. It is left to the occupiers of houses to clean these filth receptacles. It must be clear that the efficiency of these traps depends in great part upon the accuracy with which they are laid and upon the care with which their junction with the drains on either side is effected—a matter which the sanitary authority has of late years professed to supervise. The junctions are made with clay. They must necessarily become disturbed by such influences as frost and frequent cleansing, and so become gradually less efficient: this inefficiency of traps is probably most common in the older part of the town, where the soil is sandy, than in the newer part, where it is clayey.



a. Liquid matters.
b. Deposit apt to occur.

Excrement Disposal.—There are comparatively few waterclosets in Middlesbrough, viz. 801 (November 1887), such being found only in the higher class of residences, so that but little excrement gets into the sewers by direct means. In the older part of the town ashpit privies are in common use. They are of the old objectionable type, the ashpits being sunk below the ground surface and some of them being drained into the sewers. In some places they are very large, one ashpit serving for six or eight privies arranged round it, as for example, in Newcastle Row; they are mostly covered, but there is often a portion left uncovered (? for ventilation), and from this and other causes the ashpits are often found to contain a quantity of filthy liquid. They are a great nuisance wherever they exist, especially where, as in Union Cottages, they are close to the back doors and windows of dwellings. They are emptied by the sanitary authority; but I observed in particular instances that whereas the contents of the ashpit had been removed, the excrement—lying sometimes heaped upon the sloping ledge beneath the privy seat—had not always been cleared away. The mode of cleaning these places also is objectionable: the workmen throw out the mixture of water, ashes, and excrement upon the back street or surface of the court, so as to allow of the filthy liquid draining off to the nearest gully grating; and thereby they create a nuisance of a scarcely tolerable nature complaint of which was made to me, especiallyin Newcastle Row. Ash-pit privies prevail to a considerable extent also in the part of the borough to the south of the railway, but the sanitary authority have not permitted their erection in the newest parts. Here and in various places in the town generally, both to the north and south of the railway, oblong rectangular iron pans are used for the reception alike of excrement, ashes, and domestic refuse. They are visited and emptied twice a week regularly by the servants of the Corporation. They are not taken away to be cleansed, but are simply emptied, swept out roughly with a broom, dusted with some sort of carbolic powder, and replaced. The pail system would be well adapted to the town if it were properly carried out, but on the plan adopted, proper cleansing is scarcely possible.

The *footpaths* are commonly well paved, and the main *streets* and most of the older subsidiary streets are either paved or macadamised

and kept in good condition; but the "back streets" or back ways between the yards of houses in contiguous streets, are commonly either unpaved or imperfectly paved, since the Corporation has been in the habit of regarding them as "private" roads over which they could exercise no rights of ownership. Back streets are therefore often in bad condition. There are also, the surveyor informed me, some 100 street roadways badly made, and still undedicated, being as yet only partially built on.

Water Supply.—This is taken from the River Tees at Broken Scar, about 18 miles below Barnard Castle, and 2 miles above Darlington, after the river has received the sewage of Barnard Castle, as also of other places. The water is filtered and is supplied by main to Stockton, Middlesbrough, and the local board districts to the east as far as Redcar. In order to obtain a purer supply, works are now in progress for the collection of the water some miles above Barnard Castle. In November 1887 there were 13,067 domestic dwellings and tenements in the borough getting this supply, the average quantity thus given being 21,197,000 gallons weekly or over 4 gallons per head per diem.

The Climate in the colder and wet seasons of the year is damp and foggy and chilly, and the air is at all times greatly polluted with the smoke from the iron and steel works which surround the town on three sides. I am informed that in the colder seasons of the year very sudden variations of temperature are apt to take place. Effluvia from the chemical works are also much complained of. The north-east winds are especially trying, since they bring not only smoke from the furnaces but damp fogs from the marshes.

Occupations and Social Status of the Population.—I have stated above that the rapid growth of the borough has been due to the great development of the iron and steel-making industry, which has attracted thousands of a labouring population with their families, for the accommodation of whom streets of houses of the cottage class have been built in exceedingly large proportion. Middlesbrough is, in short, a town of iron workers mainly, and of shopkeepers who have settled there for the supply of the iron-workers' needs. There are few towns of similar size which contain a smaller proportion of a well-to-do residential population, or of dwelling-houses of the class that such persons would occupy. Better class houses are very few indeed in the part to the north of the railway. The following table represents this:—

TABLE showing the NUMBER of DWELLING-HOUSES in the BOROUGH in 1888, rated at the following RATEABLE VALUES.

	Under 5*l.*	5*l.* and under 10*l.*	10*l.* and under 20*l.*	20*l.* and under 30*l.*	30*l.* and under 40*l.*	40*l.* and upwards.	Total.
Number	1,405	7,460	2,143	495	164	282	11,949
Per ct. of total.	11·8	64·2	17·9	4·1	1·4	2·4	—

The labouring (iron-working) population are rough and careless in their habits. There is a great deal of intemperance, not among the men only, but also, I am informed, among the women; and hence, although the men get on an average about 30*s.* per week in wages, and might on this keep themselves and their families in

comfort, families are often squalid and the interior of cottages dirty and untidy. When off work the men are apt to congregate about the public-houses and street corners, whatever the season or weather, often thus getting wet and chilled after their day's exposure to the high temperature of the works; and when drunk, men will sometimes lie down anywhere at their homes in their wet clothes. It is the practice at the works to pay wages at 1 o'clock on Saturdays, and from that time until night this exposure of the hands to cold, with the drinking, goes on to a greater extent than on other days. They do not congregate much in public-houses on a Sunday, and usually go to work on the Monday, either on day or night shift. Work is sometimes irregular—it has been so of late in consequence of the closure of some of the factories—and then the men have to depend for a living upon any odd job they can get to do. The labouring class usually purchase fresh meat (preferably lean beef) on a Saturday for their Sunday's dinner, and it may last them for dinners on the next and succeeding days, but after that the only animal food that they get is for the most part bacon. A large proportion of the labouring population is Irish, and there are a good many Welsh.

Ormesby Local Board District.

The total area of this district is stated in the census as 2,836 acres. In 1871 it contained a population of about 4,080 persons. In 1881 there were 1,473 inhabited houses and a population of 7,719 persons. In 1888 the number of dwelling-houses was as follows :—

Return of the Number of Dwelling-Houses rated in 1888 at the following Rateable Values.

	Under 5*l.*	5*l.* and under 10*l.*	10*l.* and under 20*l.*	20*l.* and under 30*l.*	30*l.* and under 40*l.*	40*l.* and upwards.	Total.
Number	174	1,167	167	44	9	14	1,575
Per ct. of total.	11·0	74·0	10·6	2·8	0·6	1·0	—

Nearly all of these (*i.e.*, all with the exception of 14 or 15 houses in the village of Ormesby) form the small town of North Ormesby.

The only populous part of this district, therefore, is the small town of North Ormesby. It is of recent construction, virtually a suburb of Middlesbrough (sketch map No. II.). The soil on which the town stands is a stiff yellow clay, beneath which, about 12 feet down, is a hard shaly blue clay. It occupies an area of about 50 acres, and is built square, with streets at right angles to each other. There is little difference in the elevation of different parts, its average height above Ordnance datum being between 20 and 25 feet. The *streets* are wide and well aërated; and the roadways in good condition and macadamised with slag and whinstone. The "back streets" are entered at each end beneath an archway under a dwelling-house, so that, with the exception of the archway at either end, the space within a block of houses is closed on all sides. The space between the backs of the houses in the block is about 55 feet, of which 15 feet is the width of the "back way" or "back street." The back streets are unpaved and consequently generally dirty and in bad condition.

The town is *sewered* throughout with stoneware pipes; the sewers are carried through the back streets. They have good fall and discharge into a tidal beck flowing into the Tees. The road drainage is into stone-

ware trapped gullies with receivers of the same type as the trapped gullies described as introduced into house yards in Middlesbrough. The sewers are, in each back street, provided with one or two circular man-holes constructed of brick without mortar, each having (like those in the old part of Middlesbrough) a sumpt or cesspit at the bottom sunk about 2 feet 6 inches below the level of the pipe sewers which enter it. The man-holes are mostly but not all ventilated by openings in the cover; but there are also in various parts of the town, more perhaps on the north than on the south side, altogether about 20 4-inch up-cast shafts to act as additional sewer ventilators. The sumpts are, as in Middlesbrough, the depository of filthy decomposable matter from which unwholesome emanations must necessarily pass into the "back streets." It is stated by the surveyor that they are cleaned out once a month. The sewers are flushed twice a year, the contents of a 2,400 gallon boiler being thrown twice into each man-hole. Many of the cottages (it is said about a quarter of them) have sinks in the back kitchen; the pipes from about half of these are cut off outside, but the rest run underground to discharge beneath the grating of the yard gully. The yard gullies are of the same construction as in Middlesbrough, and the "receivers" of them are said to be regularly cleaned out by a servant of the local board. He throws the filth into the ashpit. Throughout the place ordinary ash-pit privies are in universal use. They were originally constructed with a pervious bottom sunk some 18 inches below the surface of the adjoining "back street," with the object of permitting liquids to soak into the house drain beneath them and so get into the sewer of the back street. None are distinctly and of set purpose drained into the sewer in any other way. They are covered, but a tile is left off for ventilation. During the last three years some of these sunk ashpits have been raised by filling in with ballast to the level of the surface and paving with bricks without mortar. But on inspecting the place, I found as a rule but few improved even to this extent. Most of the ashpits remained as originally constructed:—they were more or less wet, were all offensive,—some very much so notwithstanding that in none was there very considerable accumulation. In the few instances, on the southern part of the town, where I saw reconstructed ashpits, some even of these were wet, and they were little less offensive than those which had been unaltered. There are as a rule two privies to each ashpit of an area of 18 square feet. The ashpits are emptied by a contractor at intervals of two or three months, some it is said more frequently, and in the same way as at Middlesbrough. The *water supply* is the same as at Middlesbrough. I saw no ground for believing that it has become in any way contaminated within the town itself. It is on the constant system. The population is almost entirely of the labouring class, of like occupation and habits with that in Middlesbrough; in addition, there are some shopkeepers.

Normanby Local Board District.

The area of this district is stated in the census as 1,413 acres. In 1871 it contained a population of 3,556 persons, but in 1881 this had increased, from the same causes as the increase of population in Middlesbrough, to 7,714 persons. This and subsequent increase has occurred almost entirely in that part of Normanby which constitutes the small town of Southbank. The following statement indicates the character of the dwellings in the district; they are with very few exceptions of the cottage class, and have been built for the accommodation of the persons employed in the neighbouring works.

Return of the Number of Dwelling-Houses rated in 1888 at the following Rateable Values.

	Under 5*l.*	5*l.* and under 10*l.*	10*l.* and under 20*l.*	20*l.* and under 30*l.*	30*l.* and under 40*l.*	40*l.* and upwards.	Total.
Number	297	1,180	125	28	7	12	1,649
Per ct. of total.	18·0	71·6	7·6	1·7	0·4	0·7	—

Of the 1,649 dwellings, 1,396 are in the town of Southbank and 253 in and about the village of Normanby.

The portion of the district laid out for the town of Southbank is about 75 acres, of which, according to the district surveyor, about 50 acres are now covered with buildings. This small town is situated nearer the Tees than is Grange Town in the Eston district, and is at a lower elevation, viz., rather less than 25 feet above Ordnance datum. The surface here is flat and the streets are mostly built at right angles to each other, as are those of North Ormesby and Grange Town. The soil on which Southbank is built is clay alternating with sand or a sandy clay, and hence is not in all parts impervious to water. The *roadways* are kept in good condition; but the "back streets" are unmade and in very bad condition generally as respects surface drainage and cleanliness. In the older part of the town back streets are entered by archways under dwellings, but elsewhere they are open at the ends. The dwellings are mainly of the cottage class. The town is pipe *sewered* throughout, with an outfall to the foreshore of the Tees, where there is a tidal flap which is not very efficient. The gradients of the sewers are sufficient. Subsidiary sewers for domestic drainage are carried up the "back streets," and 9-in. and 6-in. pipes are carried into the roadways for their surface drainage. In the system of sewers there are about 40 *man-holes* all but five of them having open ventilating grids in the cover; all are circular, about 4 feet diameter, and each with a catch-pit at the bottom which is paved with bricks set on edge. Beneath each man-hole ventilator is a dirt box which is charged with carbolic powder or chloride of lime. Complaints of stench from these man-holes have been made—some were made to me personally. The complaints have sometimes been met by closing the ventilating openings and carrying a 6-in. pipe from the man-hole to the side of some building, continuing it by a 6-in. and 4-in. square metal pipe to above the eaves. The sewers in the back streets are ventilated at lamp holes at their highest part. The surveyor says that the sewers are flushed four times a year, but at no stated periods, mostly, however, in the hot season, by means of a hose at the head of each branch; or, if there be no opening in the sewer, at some yard gully opening. The man-holes are cleaned out after each flushing.

About three-fourths of the dwellings have slop sinks within them. The sink pipe in houses built during the last six years has been made to discharge on to the surface of the yard about 18 inches from the gully,—the same sort of trapped gully that has been before described as in use all over this neighbourhood. As regards older houses, commonly I found the sink pipe carried underground to discharge beneath the gully grating: a good many, however, are said to have been of late cut off, how many the surveyor cannot tell, but where this has been done the pipe has been made to discharge directly over the gully. The surveyor says that this is the case at his own house, and that when

the latter has been shut up for a night the air of the house becomes offensive from this source. The servants of the authority clean the gully "receivers" about four times in a year,—far from often enough. In about 900 of the 1,396 houses in the town the *privy arrangement* consists of oblong iron pans similar to those in use in Middlesbrough, all domestic refuse and ashes being supposed to be put into them. These pans are fairly emptied by a contractor weekly and sometimes where necessary oftener. The other houses have covered ashpit privies, one or two privies to each ashpit; the ashpits are sunk 12 or 18 inches below the surface of the ground. They are emptied about once a month. The *water supply* is from the same source as in the other towns, and there is no reason to believe that the water is polluted in its passage through Southbank. The population is mostly persons engaged in the iron industry of the district, and in shopkeeping. The labouring population resembles in its habits that of the other towns.

Normanby Village stands at an elevation of about 100 feet above Ordnance datum. It is fairly well pipe-sewered, with good falls. The soil is a mixture of yellow clay, gravel, and sand. The privies are mostly ashpit privies, covered, and generally drained into the sewers. The water supply is from wells. Water is met with in the soil at a depth of about 30 feet. The population is engaged in ironstone mining and agriculture.

Eston Local Board District.

This district, which was only constituted in 1884, has a total area of about 2,250 acres. The following statement indicates that the dwellings are mostly of the cottage class :—

Return of the Number of Dwelling-houses rated in 1888 at the following Rateable Values.

	Under 5*l.*	5*l.* and under 10*l.*	10*l.* and under 20*l.*	20*l.* and under 30*l.*	30*l.* and under 40*l.*	40*l.* and upwards.	Total.
Number	522	1,249	104	46	4	6	1,931
Per ct. of total.	27·0	64·7	5·4	2·4	0·2	0·3	—

It contains three chief centres of population :—*a.* Grange Town, a small square town of streets built at right angles to each other (in this respect resembling North Ormesby), and erected for the most part in 1882 and 1883; *b.* South Eston or Eston village, and a part called California, situated on the hill side to the south of Grange Town; and *c.* a portion of Southbank town.

Of the 1,931 dwelling-houses there are—

In Grange Town proper - - -	891
South Eston and California - - -	658
The portion forming part of Southbank -	303
Branch End, Bolckow Terrace, and Clay Lane	79

Grange Town stands at an elevation of about 35 feet above Ordnance datum, South Eston and California at an elevation of about 150 feet, and the part of Southbank included in the district, at about 25 feet or less. This Southbank portion, and the scattered groups of cottages between it and Grange Town, known as Branch End, are nearer to the river than Grange Town, and stand also at a lower level.

a. Grange Town.—The soil on which Grange Town is built is said by the district surveyor to be a stiff clay. The area covered by buildings

(dwelling-houses) is about 30 acres. Grange Town was only erected about ten years ago for the accommodation of the workpeople at Bolckow Vaughan's Steelworks, which are situated between it and the river. The place may be said to be well aërated,—the roadways being of good width, the back streets also of good width, while sufficient space is provided between the backs of houses in each block. Unlike North Ormesby, the back ways are not entered by archways under houses.

The *roadways* are well made, the "back streets" as yet unmade, but their paving is about to be commenced. The *sewering* and the house drainage of Grange Town was not effected by, nor under the supervision of, the local board. The place is pipe-sewered throughout; the subsidiary sewers are carried up the "back streets," and receive there the drains from the domestic premises. The present surveyor says he is not satisfied with the sewers so far as his examination of them has gone; they appear to have been laid without regard to proper gradients, and the joints he has found bad and leaky. In the course of the main sewer are some man-holes, each with a catch-pit at the bottom about a foot in depth. There is no ventilation provided for the sewers as they pass through the town, but there is a ventilator at the higher extremity of the system, and there are three or four ventilators in the outfall brick sewer, which terminates with a flap valve on the foreshore of the Tees. The main sewer alone is flushed, by diverting a stream of water through it. In the yard of each dwelling are two drain inlets, one close to the house, immediately over which the pipe from the sink within the dwelling discharges, and another at the far end of the yard, under the grating of which a pipe from the trap of the inlet first mentioned discharges itself. Both these inlets have stoneware traps and receivers of the type common throughout the district. The local board undertakes to clean out these receivers, but some that I saw had certainly not been cleaned out for some time, judging by the accumulation of filth in them. The yards are paved, and are usually clean and in fair condition. The surveyor could tell me nothing about the condition of the domestic drains and junctions; but, if the public sewers are defective, it may be guessed that the private drainage work is not much better. Still there is little chance apparently of sewer air entering the dwellings directly through the sink pipes, all of which are cut off outside. The ash-pit privy is not in use in Grange Town, but everywhere oblong iron receptacles are placed under the seat for the reception both of excrement and house refuse; they are emptied twice a week by the local board.

b. The soil on which *South Eston and California* are situated is stated by the district surveyor to be a light loamy clay, varying in texture, with a thin bed of gravel about 4 to 6 feet below the surface. The sewers of South Eston and the drainage generally have hitherto been unsatisfactory, but the drainage of California has been recently improved. The privy arrangement in this part is, in about one-third of the houses, pan closets, in the rest, midden privies.

c. That part of the district which has been mentioned as being virtually part of Southbank is stated to stand upon an area of about 10 acres. It is extremely badly drained, and discharges into the Southbank system, which is under the jurisdiction of the Normanby Local Board. The sewers are laid at levels and gradients which render them often quite inefficient for the carrying off of surface water (which stagnates in all waste plots of ground), and for maintaining the cleanliness of domestic premises, the yards of which, as well as the back streets, are in consequence habitually in a filthy condition. The local board

are now engaged in reconstructing the drainage of this part of its district. The privies are partly pan and partly midden privies. It is here that the lowest and worst class of occupants reside; and here also is situated the only common lodging-house of the district.

The *water supply* of the district is from the same source as that of Middlesbrough, and there is no reason for believing that it is polluted in passing through the district. The supply is on the constant system. As has been said, Grange Town is mainly inhabited by the workpeople of Bolckow Vaughan's iron and steel works, but there is a certain proportion of miners who work at the iron mines near Eston village. Of the 891 houses in Grange Town, 103 are occupied by miners, the remainder by iron-workers and a few tradespeople. At Eston village and California there is a mixed mining and agricultural population, and in the part near Southbank the population is mostly labourers at ironworks. The iron-working population differs little as to habits from that in Middlesbrough.

Rise, Progress, and Decline of the Epidemic, and its Proportions.

Tables I. and Table II. (pp. 261 to 263) may be used to trace, week by week and four weeks by four weeks, the rise, progress, and decline of the mortality, under 15 years and at ages over 15, from so-called "pneumonia" throughout the year 1888 in the town of Middlesbrough, in the three local board districts separately and conjointly, and in all four urban sanitary districts taken together. They show also the mortality registered as from "pneumonia" in each week and each four-weekly period of each of eight previous years; and Table II. is so constructed as to indicate the mortality as it affected children under 15 years of age and of persons at 15 years of age and upwards. Table III. (p. 264) also shows for each of the four urban sanitary districts the numbers of each sex that died of pneumonia in each district in each four-weekly period of 1888, and specially the sex of those which died at ages above 15 years in the three local board districts conjointly, in the borough of Middlesbrough, and in the whole of the four urban sanitary districts taken together. It further shows the number of them which died in certain age-groups in the three local board districts together, and in the borough of Middlesbrough separately.

[In all the tables of this report the deaths are entered to the weeks or lunar months in which they *occurred*, not to those in which they happened to be registered.]

Chart I. (*see* p. 212) shows graphically week by week, for persons who died of "pneumonia" at ages above 15 years, the progress of the pneumonia mortality throughout the year, both for the borough of Middlesbrough and for the three local board districts together, and also the mean weekly mortality from "pneumonia" in each of the above localities during the previous eight years, as well as the relations of the 1888 mortality to certain meteorological conditions. Chart II. (*see* p. 212) shows much the same particulars in four-weekly periods, but in addition the mortality from "pneumonia" of persons under 15 years of age.

The rise, progress, and decline of the epidemic, so far as they can be judged of from the mortality it occasioned, may be best studied by confining attention to the deaths of persons over 15 years of age, and I propose to use the Table I. (*b*) and the Chart I. for this purpose accordingly. The reason of this will be obvious on looking at Chart II. (*b*), which indicates to how small an extent the epidemicity

of the "pneumonia" among children affected the total pneumonia mortality of 1888, as compared with the mean total mortality of previous years; although I have grounds for believing that children were not exempt from the epidemic sickness. The age of 15 is specially selected as dividing off the age-groups, because it is about the age of commencing puberty, and is the age at which children of the labouring class begin to work for their living.

The mortality from "pneumonia" over 15 years of age in the combined districts of Middlesbrough, Ormesby, Normanby, and Eston (see Table I. (*b*), Chart I., and Chart II. (*a*)) began to assume epidemic proportions about the fifth or sixth week of 1888. Looking at the customary duration of the fatal cases, it may therefore be fairly assumed that the malady to which this report relates began to spread epidemically in the fourth or the fifth week of the year. By the ninth week of the year the epidemic had attained considerable proportions, as many as 16 deaths in the whole conjoined district having occurred in that week. For the next seven weeks the deaths fluctuated between 7 and 14 weekly, but in the 17th week they rose to 19, then declined during two weeks to 11, but in the 21st week rose again suddenly to 33. Thereafter the deaths maintained a high level for three weeks, but in the 24th week there was a sudden fall to 13, after which the mortality gradually decreased until in the 32nd week of the year it reached the mean of the eight previous years. For all practical purposes the epidemic mortality may be regarded as at an end by the 29th week; since, after this, although the mortality was more or less considerably above the average and continued on the whole above it until nearly the end of the year (showing that the disease which had been so fatal to the population was not even yet actually extinct), it ceased to present such alarming proportions as it had presented previously. It will be observed by looking at Chart I. how uniformly the fluctuations of the mortality in the three local board districts taken together, coincided on the whole with those in the town of Middlesbrough.

The following Table A. shows, for each of the urban areas and for the entire district,* the number of "pneumonia" deaths at *all ages* and for both sexes separately and conjointly, which occurred:—1°, *during the whole year of* 1888; 2°, during a period of four weeks in the month of January; 3°, during the (adopted) epidemic period of 24 weeks succeeding; and 4°, during the remaining or "*post*-epidemic" period of 24 weeks to the close of the year.

Table A.

1888.	Middlesbrough.			Ormesby.			Normanby.			Eston.			Entire District.		
	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.
During 4 first weeks -	9	2	11	—	2	2	—	—	—	7	6	13	16	10	26
„ 24 epidemic weeks (5th to 28th).	232	53	285	8	7	15	29	8	37	19	13	32	288	81	369
„ remainder of year (24 weeks).	52	21	73	3	—	3	8	5	13	4	2	6	67	28	95
During whole year -	293	76	369	11	9	20	37	13	50	30	21	51	371	119	490

* By the "entire district," wherever in this report this term is used, is signified the four urban sanitary districts taken together.

Table B. gives similar facts for the eight previous years, 1880 to 1887 inclusive :—

TABLE B.

1880 to 1887.	Middlesbrough.			Ormesby.			Normanby.			Eston.			Entire District.		
	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.
During 4 first weeks -	41	19	60	8	11	19	8	3	11	16	4	20	73	37	110
„ 6 lunar months - (5th to 28th week).	318	162	480	33	19	52	64	29	93	62	26	88	477	236	713
„ remainder of year (24 or 25 weeks).	215	119	334	24	21	45	40	32	72	60	48	108	339	220	559
Total - - -	574	300	874	65	51	116	112	64	176	138	78	216	889	493	1,382

THE ANNUAL MEANS BEING—

During 4 first weeks -	5·1	2·4	7·5	1·0	1·4	2·4	1·0	0·4	1·4	2·0	0·5	2·5	9·1	4·7	13·7
„ 6 lunar months	39·7	20·2	60·0	4·2	2·4	6·5	8·0	3·6	11·6	7·8	3·2	11·0	59·6	29·6	89·1
„ remainder of year (24 or 25 weeks).	26·9	14·9	41·7	3·0	2·6	5·6	5·0	4·0	9·0	7·5	6·0	13·5	42·4	27·5	69·9
During the whole year -	71·7	37·5	109·2	8·1	6·4	14·5	14·0	8·0	22·0	17·2	9·7	27·0	111·1	61·6	172·7

In respect of the *Entire District*, and for 1888, the above tables show—

1°. That altogether 490 deaths from "pneumonia" at *all ages* occurred *in the course of the whole year* and that this mortality was 2·8 times that of the mean mortality from "pneumonia" during the previous eight years.

2°. That during the *first four weeks of the year* 26 deaths occurred, and that this mortality was 1·9 times that of the mean of eight years.

3°. That in the (adopted) "*epidemic*" *period* of 24 weeks 369 deaths occurred, and that this mortality was 4·1 times that of the mean of eight years.

4°. That in the "*post-epidemic*" *period* 95 deaths occurred, and that this mortality was 1·4 times that of the mean of eight years.

But in estimating the value of these excesses over the mean it must be kept in mind that the district had a rapidly increasing population which was under 81,000 in 1881 and is estimated at 97,606 in 1888.

As respects each of the four urban sanitary districts the Tables A. and B. show that—

1°. Of the total pneumonia deaths *at all ages* in the *whole of* 1888 :—

In *Middlesbrough* there were—
369 deaths, or 3·4 times the mean of eight previous years.

In *Normanby* district there were—
50 deaths, or 2·3 times the mean of eight previous years.

In *Eston* there were—
51 deaths, or 1·9 times the mean of eight previous years.

In *Ormesby* there were—
20 deaths, or 1·3 times the mean of eight previous years.

So far as this all-age table goes it shows that the pneumonia mortality was in excess of the mean of 8 years in the several urban sanitary districts in the order in which they stand above.

But again the increase of population, the rate of which differed in these several districts, has to be taken into account:—

In Middlesborough the population increased from—
55,934 in 1881 to 69,255 (estimated) in 1888.

In Normanby district the population increased from—
7,714 in 1881 to 9,069 (estimated) in 1888.

In Eston the population increased from—
less than 10,000 in 1881 to 10,620 (estimated) in 1888.

In Ormesby the population increased from—
7,719 in 1881 to 8,662 (estimated) in 1888.

As respects the distribution of the pneumonia deaths *at all ages* in each urban sanitary district separately in the four first weeks of the year and in the "epidemic" and "post-epidemic" periods of the year, the Tables A. and B. show:—

2°. That during the *first four weeks* of the year the pneumonia mortality was—

In Eston—
13, or 5·2 times the mean of eight previous years.*

In Middlesborough—
11, or 1·5 times the mean of eight previous years.

In Ormesby—
2, or 0·8 of the mean of eight previous years (or $\frac{1}{6}$th less than the mean).

In Normanby—
Nil.

It was only in Eston and Middlesbrough then that there was evidence from the all-age tables of mortality of a commencement of epidemic mortality in these weeks.

3°. That during the 24 epidemic weeks constituting the "*epidemic*" *period* the "pneumonia" mortality was—

In Middlesbrough—
285, or 4·7 times the mean of eight previous years.

In Normanby—
37, or 3·2 times the mean of eight previous years.

In Eston—
32, or 2·9 times the mean of eight previous years.

In Ormesby—
15, or 2·3 times the mean of eight previous years.

4°. That during the remaining 24 weeks (*i.e.*, from the 29th week to the close of the year) constituting the "*post-epidemic*" period the pneumonia mortality was—

In Middlesbrough—
21, or 1·8 times the mean of the eight previous years.

In Normanby—
13, or 1·4 times the mean of the eight previous years.

In Ormesby—
3, or 0·5 of the mean of the eight previous years (or about half the mean).

In Eston—
6, or 0·4 of the mean of the eight previous years (or about half the mean).

From which it may be gathered, so far as the *all-age* tables can instruct us, that it was only in Middlesbrough and Normanby that any excess of pneumonia mortality lingered after the expiration of the 28th week of the year.

* But it will be seen in the sequel that the $\frac{9}{13}$ths of the Eston pneumonia mortality at this period was in children.

And the larger inference to be drawn from the foregoing facts is:—*first*, that the malady which here gave rise to the excessive mortality, registered under the term "pneumonia," commenced in the Eston and Middlesbrough districts; *secondly*, that during the 24 (adopted) epidemic weeks it prevailed in all the districts, but unequally; and *thirdly*, that after the expiration of these weeks it practically disappeared from Ormesby and Eston districts, but did not entirely disappear from Middlesbrough and Normanby districts.

But the proportions of the epidemic in the *entire* district, and in its several parts, may be best studied upon the mortality of *persons over 15 years of age*.

The following Tables C. and D. exhibit the data for a study of this kind. Table C. shows, for each of the four urban districts and for the entire district, the number of deaths of persons aged 15 years and upwards (registered as due to "pneumonia") which occurred:—1°, during the whole year 1888; 2°, during the four first weeks of the year; 3°, during the "epidemic"; and 4°, during the "post-epidemic" period.

Table C.

—	Middlesbrough.			Ormesby.			Normanby.			Eston.			Entire District.		
	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.
During first 4 weeks -	7	1	8	—	1	1	—	—	—	2	2	4	9	4	13
„ 24 epidemic weeks	217	48	265	8	7	15	25	6	31	13	10	23	263	71	334
„ remainder of year	37	10	47	3	—	3	5	3	8	2	1	3	47	14	61
During whole year -	261	59	320	11	8	19	30	9	39	17	13	30	319	89	408

Table D. gives similar facts for the eight previous years, 1880 to 1887 inclusive:—

Table D.

—	Middlesbrough.			Ormesby.			Normanby.			Eston.			Entire District.		
	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.
During first 4 weeks -	29	10	39	2	1	3	4	—	4	9	1	10	44	12	56
„ 24 epidemic weeks	245	94	339	19	9	28	40	15	55	45	13	58	349	131	480
„ remainder of year	133	62	195	8	8	16	22	10	32	22	18	40	185	98	283
During whole year -	407	166	573	29	18	47	66	25	91	76	32	108	578	241	819
The Annual Means being—															
During first 4 weeks -	3·6	1·2	5·0	0·2	—	0·4	0·5	—	0·5	1·1	0·1	1·2	5·5	1·5	7·0
„ 24 epidemic week	30·6	11·7	42·4	2·4	1·1	3·5	5·0	1·9	6·9	5·6	1·6	7·2	43·6	16·4	60·0
„ remainder of year	16·6	7·7	24·4	1·0	1·0	2·0	2·7	1·2	4·0	2·7	2·2	5·0	23·1	12·2	35·4
During whole year -	50·9	20·7	71·6	3·6	2·2	5·9	8·2	3·1	11·4	9·5	4·0	13·5	72·2	30·1	102·4

Taking then the mortality of *persons* 15 *years old and upwards* as the more satisfactory criterion of the proportions of the epidemic, what the above Tables C. and D. teach us in respect of the *entire district* is this:—

1°. That 408 deaths from pneumonia *at these ages* occurred *in the course of the whole year* 1888, and that this mortality was 4 times that of the mean mortality from pneumonia during the previous eight years.

2°. That in the *first four weeks* of the year 13 deaths occurred, and that this mortality was 1·8 times that of the mean of eight years.

3°. That in the (adopted) "*epidemic*" period 334 deaths occurred, and that this mortality was 5·6 times that of the mean of eight years.

4°. That in the "*post epidemic*" period 61 deaths occurred, and that this mortality was 1·7 times that of the mean of eight years.

As respects the *distribution* of these deaths *at* 15 *years and upwards* among the four urban sanitary districts the Tables C. and D. show—

1°. That *in the course of the whole year*—

In *Middlesbrough* there were—
320 deaths, or 4·5 times the mean of eight previous years.
In *Normanby* district there were—
39 deaths, or 3·4 times the mean of eight previous years.
In *Eston* there were—
30 deaths, or 2·2 times the mean of eight previous years.
In *Ormesby* there were—
19 deaths, or 1·2 times the mean of eight previous years.

The above order of sanitary districts may therefore be taken as that in which, during all 1888, the districts suffered from the excess of mortality occasioned by the malady over the mean of pneumonia deaths of the previous eight years. In using these figures as criteria of *prevalence* of the malady, however, two considerations must be taken into account, viz., (*a*) the varying annual increase of population in each, and (*b*) variations in respect of the fatality of the disease among those attacked.

As respects the distribution of the deaths *at* 15 *years and upwards* among the urban sanitary districts in the "pre-epidemic," "epidemic," and "post-epidemic" periods of the year, the Tables C. and D. show—

2°. That during the *first four weeks* of the year the "pneumonia" mortality *at ages above* 15 was—

In Eston 4, or 3·3 times the mean of the eight previous years.
In Ormesby 1, or 2·5 times the mean of the eight previous years.
In Middlesbrough 8, or 1·6 times the mean of the eight previous years.
In Normanby, nil.

Practically then it was only in Eston that the mortality showed in January 1888 any positive excess over the mean,—an indication that it was in this district that the epidemic prevalence really commenced. (But it may be hereafter of service to note at once that throughout the eight previous years Eston had at this early part of the year exhibited a greater relative mortality from pneumonia at these ages than the other sanitary districts.)

3°. That during the (adopted) "*epidemic*" period the "pneumonia" mortality *at ages above* 15 was—

In Middlesbrough 265, or 6·2 times the mean of the eight previous years.
In Normanby 31, or 4·5 times the mean of the eight previous years.
In Ormesby 15, or 4·3 times the mean of the eight previous years.
In Eston 23, or 3·2 times the mean of the eight previous years.

4°. That during the "*post-epidemic*" period the "pneumonia" mortality *at ages above* 15 was—

In Normanby 8, or 2 times the mean of the eight previous years.
In Middlesbrough 47, or 1·9 times the mean of the eight previous years.
In Ormesby 3, or 1·5 times the mean of the eight previous years.
In Eston 3, or 0·6 of the mean of the eight previous years.

The general inference then, so far as deaths of persons *at 15 years of age and upwards* are concerned, as to prevalence of the epidemic malady, would therefore appear to be this, viz. :—

1°. That it showed itself earliest in the Eston Local Board district, in the first four weeks of the year.

2°. That in the "epidemic" period of 24 weeks, from January 29 to July 14, it prevailed most extensively in the borough of Middlesbrough; less so (and about equally) in Ormesby (virtually a suburb of Middlesbrough) and in Normanby; and least of all in Eston.

3°. That in the "post-epidemic" period of 24 weeks, from July 15 to the close of the year, the disease lingered most, and in about an equal degree, in Middlesbrough and Normanby; less obviously in Ormesby; but disappeared entirely from Eston Local Board district.

So far, the statistics of pneumonia mortality I have adduced do not take account of diverse increase, in one and another district, of population during the eight years 1880–87; nor of variations in the fatality of the disease at different times in different places. Consideration will be given to these matters in due course; but here it may be well to point out that the malady under consideration did not as a fact prevail epidemically at any period of 1888 in the immediately adjoining parts of the country; not even in the adjoining parts of the Middlesbrough poor law union (which include the urban sanitary district of South Stockton) outside the four urban sanitary districts above specified.

Prevalence of the Pneumonia Mortality in 1888 *as shown by its Incidence on Population.*

The following table will show this for the *entire* district and for each of the *several urban sanitary districts* included therein, as respects the mortality *at all ages during the whole year.*

—	Entire Population. All Ages. (Estimated.)	Deaths. All Ages.	Per 10,000 of Population. All Ages.
Borough of Middlesbrough -	69,255	369	53·3
Local Board District of Ormesby -	8,662*	20	23·1
,, ,, Normanby	9,069	50	55·1
,, ,, Eston -	10,620	51	48·0
Entire district - -	97,606	490	50·2

* I am not quite satisfied with this estimate. It may be stated here that the estimate for Middlesbrough is one carefully made by Dr. Malcomson, the Medical Officer of Health: the other estimates are based upon tables of inhabited dwelling-houses, furnished me by the clerks of the local board districts, by calculating 5½ persons to a house.

There was not then rateably, *for all ages*, any very great difference between its incidence during *the whole year* on Middlesbrough, Normanby, and Eston; but on Ormesby it was only about half what it was upon the other sanitary districts.

But confining, as before, attention to the *mortality at 15 years and upwards*, the result *for the whole year* is shown in the following table :—

—	Estimated Population. 15 years upwards.	Deaths. 15 years upwards.	Per 10,000 of Population. 15 years upwards.
Borough of Middlesbrough -	41,362	320	77·4
Local Board District of Normanby	5,489	39	71·1
„ „ Eston -	6,320	30	47·5
„ „ Ormesby -	4,911*	19	38·7
Entire district - -	58,082	408	70·2

* See footnote to preceding Table.

During the 24 *epidemic weeks* alone the incidence of the mortality upon the population at 15 years and upwards was—

—	Deaths.	Rate per 10,000 living at 15 years upwards.
Middlesbrough - - -	265	64·1
Normanby - - -	31	56·5
Eston - - - -	23	36·4
Ormesby - - - -	15	30·5
	334	57·5

If, then, we accept the mortality at 15 years upwards as the criterion of prevalence of the malady in the several districts, it would appear that Middlesbrough and Normanby suffered from it most severely, and Eston and Ormesby considerably less—Ormesby indeed least of all. This is much the same result as was reached by comparing the pneumonia mortality of each district in 1888 with the mean mortality of each distict during eight previous years.

Incidence of the "Pneumonia" on the Sexes.

The following Table E. shows for the entire district and for each sanitary area, the number of males and of females *at all ages* who died from "pneumonia,"—*during the entire year* 1888, during the first

four weeks of the year, and during the "epidemic" and "post-epidemic" periods respectively :—and as well the proportion of each sex per cent. of the total pneumonia deaths :—

Table E.

Deaths in 1888.

	Deaths of Males and Females from "Pneumonia."								Male Deaths and Female Deaths per cent., in each instance of Total Pneumonia Deaths, in each Period.							
	During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Year.		During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Year.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Middlesbrough	9	2	232	53	52	21	293	76	81·8	18·2	81·4	18·6	71·1	28·9	79·4	20·6
Ormesby -	—	2	8	7	3	—	11	9	—	100·0	53·3	46·7	100·0	—	55·0	45·0
Normanby -	—	—	29	8	8	5	37	13	—	—	78·4	21·6	61·5	38·5	74·0	26·0
Eston - -	7	6	19	13	4	2	30	21	53·8	46·2	59·4	40·6	66·7	33·3	58·8	41·2
Entire district	16	10	288	81	67	28	371	119	61·5	38·5	78·0	22·0	70·5	29·5	75·7	24·3

Table F. shows similar facts for the eight previous years, 1880 to 1887 inclusive :—

Table F.

Deaths, 1880 *to* 1887.

	Deaths of Males and Females from "Pneumonia."								Male Deaths and Female Deaths per cent., in each instance of Total Pneumonia Deaths, in each Period.							
	During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Eight Years.		During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Eight Years.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Middlesbrough	41	19	318	162	215	119	574	300	68·3	31·7	66·2	33·8	64·4	35·6	65·7	34·3
Ormesby -	8	11	33	19	24	21	65	51	42·1	57·9	63·5	36·5	53·3	46·7	56·0	44·0
Normanby -	8	3	64	29	40	32	112	64	72·7	27·3	68·8	31·2	55·5	44·5	63·6	36·4
Eston - -	16	4	62	26	60	48	138	78	80·0	20·0	70·5	29·5	55·5	44·5	63·9	36·1
Entire district	73	37	477	236	339	220	889	493	66·4	33·6	66·9	33·1	60·6	39·4	64·3	35·7

In connexion with the above Tables E. and F. the previous Tables A. and B. (pp. 177 and 178), affording comparison of the mean deaths in each sex during eight years with the deaths in each sex during 1888, may be considered. Both sets of tables deal with deaths *at all ages* together. And Table III. (p. 264) may also be usefully consulted in reference to this matter of sexual differences so far as regards the year 1888, as also Table IV. (p. 265).

The following inferences may be drawn from the above-mentioned tables, as respects deaths *at all ages taken together* :—

1°. That during the year 1888 the deaths from "pneumonia" in the *entire district* in males amounted to more than three times those that occurred in females.

2°. That in *each of the four sanitary districts* included in the inquiry the male deaths exceeded the female deaths, but not to the same extent in each, for

3°. That the excess of male deaths was much greater in Middlesbrough and in Normanby (between which there was not much difference in this respect) than in Ormesby and Eston.

4°. That in respect of the *entire district* this excess of male deaths was observable in each of the three periods into which the year has been divided, but

5°. That the excess of male deaths was greatest in the "epidemic" period, rather less in the "post-epidemic," and much less in the first four weeks of the year.

6°. That this order of excess of male deaths in the three several periods did not hold good *in each of the four districts* separately; for that—

in Middlesbrough the order of periods in this respect was: first four weeks of year and "epidemic" period much the same; "post-epidemic" least male excess;
in Ormesby the order was "post-epidemic," "epidemic," first four weeks of year, (but here only small numbers are being dealt with);
in Normanby the order was of that of the entire district;
in Eston the order was "post-epidemic," "epidemic," first four weeks of year;
No deaths of males at all occurred during the first four weeks of the year in Ormesby and Normanby.

But it is to be observed now that an excess at all ages of male over female "pneumonia" deaths was not peculiar to 1888; for it was a character pertaining to "pneumonia" as observed, in regard of the entire year (Table IV.), during the total eight previous years in the aggregate, as well as during each individual year; and further, with only four exceptions (and these in districts in which the total numbers were small, and therefore of little statistical value), it was observed in each year in each district included in the inquiry. Excess of incidence on males was the rule then for fatal pneumonia in Middlesbrough and its neighbourhood. But the degree or amount of excess was not the same for each year either in the case of the entire district or of the four sanitary districts separately. It was greater in some years and less in others, as (for the entire district and each sanitary district separately) may be seen by reference to Table IV. Nor does it appear from this table that the annual variations of male excess were at all due to variations in prevalence of the mortality registered at all ages as due to "pneumonia." It must then have been due to something else, perhaps to annual variations in the proportions of the two sexes. It does not seem due to any variation in the quality of the pneumonia in the years of greater excess of incidence on males (assimilating it to the pneumonia of 1888), for if it had been so we should have expected that those would have been years exhibiting at least some slight indication of epidemic prevalence; but it was not so. All that I have said above with reference to the entire district applies particularly to the largest of its constituent parts, viz., the borough of Middlesbrough. It may be worth noting for future use that as soon as Eston district had grown in population to nearly its present size, the annual variations as to

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excess of male deaths came to correspond most closely with those of Middlesborough—much more so than did those of Ormesby or Normanby.

Again, therefore, attention may be most usefully concentrated upon the pneumonia mortality *in persons aged* 15 *years and upwards*, and the following Tables G. and H., constructed similiarly to Tables E. and F., may be used for this purpose ; and in connexion here with Tables C. and D., and Tables III. and V. at the end of this report may be consulted.

Table G. shows separately for the entire district and for each sanitary area the number of males and of females who died from pneumonia *at ages* 15 *years upwards* during the entire year 1888, and in each of the several divisions of the year ; and as well the proportion of each sex per cent. of the total pneumonia deaths.

Table G.

Deaths in 1888.

	Deaths of Males and Females from "Pneumonia," at Ages 15 years and upwards.								Male Deaths and Female Deaths per cent., in each instance of Total Pneumonia Deaths, in each Period.							
	During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Year.		During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Year.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Middlesbrough	7	1	217	48	37	10	261	59	87·5	12·5	81·9	18·1	78·7	21·3	81·6	18·4
Ormesby -	—	1	8	7	3	—	11	8	—	100·0	53·3	46·7	100·0	—	57·9	42·1
Normanby -	—	—	25	6	5	3	30	9	—	—	80·6	19·4	62·5	37·5	76·9	23·1
Eston - -	2	2	13	10	2	1	17	13	50·0	50·0	56·5	43·5	66·6	33·4	56·7	43·3
Entire district	9	4	263	71	47	14	319	89	69·2	30·8	78·7	21·3	77·0	23·0	78·2	21·8

Table H. shows similar facts for the eight previous years, 1880 to 1887 inclusive :—

Table H.

Deaths 1880 *to* 1887.

	Deaths of Males and Females from "Pneumonia," at Ages 15 years and upwards.								Male Deaths and Female Deaths per cent., in each instance of Total Pneumonia Deaths, in each Period.							
	During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Eight Years.		During first Four Weeks of Year.		Epidemic Period.		Post-Epidemic Period.		Whole Eight Years.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Middlesbrough	29	10	245	94	133	62	407	166	74·4	25·6	72·3	27·7	68·2	31·8	71·0	29·0
Ormesby -	2	1	19	9	8	8	29	18	66·6	33·4	67·9	32·1	50·0	50·0	61·7	38·3
Normanby -	4	—	40	15	22	10	66	25	100·0	—	72·7	27·3	68·7	31·3	72·5	27·5
Eston - -	9	1	45	13	22	18	76	32	90·0	10·0	77·6	22·4	55·5	44·5	70·4	29·6
Entire district	44	12	349	131	185	98	578	241	78·6	21·4	72·7	27·3	65·4	34·6	70·6	29·4

The exclusion of the mortality *under* 15 *years* of age in 1888 (Table G.) does not alter materially the inferences (1° to 6°) drawn from Tables E. and F. and stated on p. 184, as respects deaths at all ages.

All the considerations detailed in the preceding part of this section of the report, tend to minimise the value of the figures showing that great excess of male over female deaths was a special character in the

"pneumonia" of 1888 in Middlesbrough and its neighbourhood. The whole difference in this respect from the mean of the eight previous years *may* merely have been due to an excess in the population (above the mean of these years) of male over female persons,—to the nomadic male population having been in 1888 unusually numerous in consequence of some greater demand for labour in the works of the district. And a similar explanation very probably applies to the annual variations of excess of male over female deaths shown for the entire district and for the several sanitary districts in Tables IV. and V. at the end of this report. It will be observed in confirmation of this inference that in some years, both in the entire district and in each sanitary district, the male percentage of pneumonia deaths exceeded more or less considerably the per-centage observed in 1888.*

* An excess of male over female deaths from pneumonia is the rule in this country. It is observed not only as respects all ages together, but also in persons under 15 years of age and in persons aged 15 years and upwards :—is most marked, however, in respect to the latter age-group. This is shown by the following table :—

England and Wales.

Deaths from Pneumonia at all Ages and in certain Groups of Ages during the Eight Years 1880–87.

Ages.	0–	1–	5–	15–	25–	35–	45–	55–	65 upwards.	All Ages.
Males - -	26,054	27,878	5,169	5,740	8,988	12,421	13,230	12,631	13,761	125,872
Females - -	19,463	25,829	5,202	3,967	5,696	6,512	5,910	7,652	11,721	91,952
Totals -	45,517	53,707	10,371	9,707	14,684	18,933	19,140	20,283	25,482	217,824
Per cent. of males to totals.	57·26	51·91	49·84	59·13	61·21	65·60	69·12	62·27	54·00	57·79

Deaths from Pneumonia during each of the Eight Years 1880–87.

Under 15 Years.

Years.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Totals.
Males - -	7,219	6,489	7,447	7,545	7,173	7,772	7,349	8,107	59,101
Females - -	6,238	5,477	6,376	6,240	6,147	6,651	6,335	7,030	50,494
Totals -	13,457	11,966	13,823	13,785	13,320	14,423	13,684	15,137	109,595
Per cent. of males to totals.	53·64	54·23	53·87	54·73	53·85	53·89	53·70	53·56	53·93

15 Years and Upwards.

Years.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Totals.
Males - -	7,387	7,316	7,543	8,837	8,014	9,220	8,744	9,710	66,771
Females - -	4,322	4,420	4,692	5,573	4,912	5,733	5,670	6,136	41,458
Totals -	11,709	11,736	12,235	14,410	12,926	14,953	14,414	15,846	108,229
Per cent. of males to totals.	63·19	62·34	61·65	61·33	62·00	61·66	60·66	61·28	61·69

[*Footnote continued on next page.*

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Incidence of the Pneumonia upon the different Ages.

This may be studied upon Table VI. (p. 269), in respect of the entire district and in respect of each sanitary district included therein. In the table the deaths are distributed into 13 four-weekly periods. Further information on this head may be gathered from Table III. (p. 264).

It appears from Table VI. that of the total 490 deaths registered in the entire district as due to "pneumonia" during the whole year 1888, there were:—

Under 5 years of age				-	-	-	68 deaths.
At 5 and under 15 years				-	-	-	14 „
„ 15	„	25	„	-	-	-	26 „
„ 25	„	35	„	-	-	-	71 „
„ 35	„	45	„	-	-	-	91 „
„ 45	„	55	„	-	-	-	81 „
„ 55	„	65	„	-	-	-	89 „
„ 65 and upwards				-	-	-	50 „

Hence, inasmuch as the number of persons living at the different decennial age-periods naturally lessen as the ages advance in the series, the incidence on the mortality from five years upwards becomes obviously greater and greater. But while it has seemed to me desirable to construct Table VI. for purposes of reference, it will be more convenient, as well as sufficient for discussing the age-question generally, to make use of the summary at the end of it, and of the figures in Table III., which are constructed so as to show the deaths in larger age-groups. In these Tables and in others (pp. 264, *et seq.*), the deaths are distributed into four age-groups, viz., 1°. Into ages under 15 years: this group contains not only infants under 5 years, but also children between 5 and 15 years, who mostly, I presume, go to school. No erroneous statistical inference of consequence can arise from including the last-mentioned 10 years of age, since the numbers who died at those ages was comparatively very small, only 14 or 17 per cent. of all under 15. 2°. Into ages 15 to 35, which include persons commencing to work, and also a large portion of the nomadic part of the labouring male popula-

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Footnote continued.]

But two other things are apparent, viz.: first that during the aggregate of the same years the male excess was at all ages, as well as at ages 15 years and upwards, greater in the entire Middlesbrough district, and in each separate district except Ormesby (see Tables F. and H.) than in England and Wales; and secondly, that the annual variations in this respect (see Tables IV. and V., pp. 265 and 267) were very much greater in the entire Middlesbrough district and its several parts than in England and Wales at large.

It must here be pointed out, however, that in 1881 the male population formed—

In England and Wales *at all ages*	48·7	per cent. of the total population.
In Middlesbrough (entire district, excepting Eston not then formed into a local board district, see Table I. p. 189) at all ages - - -	52·7	„ „ „
and		
In England and Wales *at 15 years and upwards* - - -	47·9	per cent. of the total population at these ages.
In Middlesbrough (entire district, excepting Eston not then formed into a local board district, see Table I., p. 189) -	54·7	„ „ „

So that after all, as compared with England and Wales, the pneumonia indigenous to Middlesbrough does not appear really to have attacked males during eight years so disproportionately as would seem at first sight.

tion. 3°. Into ages 45 to 65, which include persons of middle age and mostly of settled occupations and residence. And lastly, 4°. Ages above 65, which age-group includes persons no longer able to work, and dependent on the help of their friends or upon poor law aid for their support.

To obtain a correct notion of the incidence of the "pneumonia" mortality upon each of these age-groups. the number of deaths must be compared with the number of persons living at similar ages. The following Tables I and J show the census population in 1881 in these several age-groups, and the estimated* population in the same age-groups in 1888 :—

Table I.

Population as given in Census Tables.

1881.

Years.	0-	15-	45-	65 up.	15 up.	All Ages.
Middlesbrough—Male -	11,152	14,134	3,363	526	18,023	29,175
Female	11,376	11,958	2,851	574	15,383	26,759
Male and Female	22,528	26,092	6,214	1,100	33,406	55,934
Ormesby—Male - -	1,716	1,900	424	72	2,396	4,112
Female -	1,626	1,562	354	65	1,981	3,607
Male and Female	3,342	3,462	778	137	4,377	7,719
Normanby—Male -	1,509	2,286	470	59	2,815	4,324
Female -	1,536	1,448	346	60	1,854	3,390
Male and Female	3,045	3,734	816	119	4,669	7,714

Eston—Males and Females. Stated by the clerk to the local board as about 10,000 at the time of constitution of the urban sanitary district in 1884.

Table J.

Estimated Population in 1888. Both Sexes.

Years.	0-	15-	45-	65 up.	15 up.	All Ages.
Middlesbrough - -	27,893	32,306	7,699	1,357	41,362	69,255
Ormesby - - -	3,751	3,885	872	154	4,911	8,662
Normanby - -	3,580	4,390	959	140	5,489	9,069
Eston - - -	4,300	4,954	1,164	202	6,320	10,620
Entire district - -	39,524	45,535	10,694	1,853	58,082	97,606

* In the cases of Middlesbrough, Ormesby, and Normanby I have taken as the basis of the estimate the age-distribution as given in the census tables for 1881. But I could not do this in the case of the Eston district, which was not constituted until 1884, and is therefore not to be found in the census tables. Accordingly I have, in the matter of age-periods, distributed the estimated population of Eston similarly to that obtaining in 1881 in Middlesbrough, Ormesby, and Normanby taken together.

Calculating the incidence of "pneumonia" in the two sexes together and for the entire year, upon this Table J., the results per 10,000 living in each age-group are as follows:—

Table K.

	Deaths from Pneumonia, in 1888.						Rates per 10,000 living in each Age-Group.					
	0–	15–	45–	65 up.	15 up.	All Ages.	0–	15–	45–	65 up.	15 up.	All Ages.
Middlesbrough -	49	141	143	36	320	369	17·6	43·6	185·7	265·3	77·4	53·3
Ormesby - -	1	12	4	3	19	20	2·7	30·9	45·9	194·8	38·7	23·1
Normanby -	11	20	15	4	39	50	31·0	45·6	156·4	285·7	71·1	55·1
Eston - -	21	15	8	7	30	51	48·8	30·3	68·7	346·5	47·5	48·0
Entire District -	82	188	170	50	408	490	20·7	41·3	150·9	269·8	70·2	50·2

Table K. thus shows—

1°. That the all-ages pneumonia death-rate of the whole year 1888, in the entire district, was 50·2 per 10,000 living; and that for persons of working age and old persons together it was some $3\frac{1}{2}$ times that of the death-rate under 15 years of age.

2°. That for the entire district there was a steady and progressive increase of death-rate with age; that during the most active period of adult life, *i.e.*, from 15 to 45 years, a period of adult life during which the fatal operation of morbid causes is most easily resisted, the death-rate was only twice that of the children under 15 years of age; that between 45 and 65 years of age the death-rate was above $3\frac{1}{2}$ times that between 15 and 45; and that at ages above 65 years the death-rate was about $1\frac{7}{9}$ times that at ages between 45 and 65, and $6\frac{1}{2}$ times that between 15 and 45 years of age.

3°. These ratios of death-rate at the various ages specified were not maintained equally in all the districts.

4°. The table confirms the inferences drawn in another way (Tables A. and B., and Tables C. and D.) as to the different degrees of incidence of the "pneumonia" upon the several sanitary districts included in the inquiry.

But now, with a view to discover whether the above age-distribution of mortality differs at all from that of the pneumonia mortality as it has been customarily observed of late years in the same locality, some further comparisons must be made.

And first of all a comparison may be made with the pneumonia mortality of the previous eight years. It may suffice to do this for the entire district, and assuming, as before, that the age-distribution of the population in 1888 was the same as in 1881, to do it by comparing the per-centage of the total pneumonia deaths that took place at the several ages in 1888 with the similar per-centage of the pneumonia deaths that took place during the eight years 1880 to 1887. This has been done in Table L.

Table L.

Entire District.

Years.	Deaths from Pneumonia in Age-Groups.						Deaths in each Age-Group per cent. of Deaths at all Ages.				
	0–	15–	45–	65 up.	15 up.	All Ages.	0–	15–	45–	65 up.	15 up.
1888 - - -	82	188	170	50	408	490	16·7	38·4	34·7	10·2	83·3
1880 to 1887 -	563	421	307	91	819	1,382	40·7	30·5	22·2	6·6	59·3

Or limiting the comparison to ages above 15 years, we obtain this result:—

—	Deaths in each Age-Group above 15 years per cent. of all Pneumonia Deaths at 15 years upwards.		
	15–	45–	65–
1888 - -	46·1	41·7	12·3
1880–87 - -	51·4	37·5	11·1

What we arrive at, then, is this—

1°. That the excess in 1888 of pneumonia mortality above the mortality of eight previous years in the same district fell practically, not on the children of the population, but upon those of working age and upon old people, and chiefly upon those above 45 years of age.

2°. That as a matter of fact this "pneumonia" mortality of 1888, in so far as it affected persons over 15 years of age, was not distributed among the age-groups in any very remarkable degree differently from the "pneumonia" of the eight previous years.

Comparing now the rates of mortality in the three adopted periods of the year, the results are as follows:—

TABLE M.

SHOWING the INCIDENCE of PNEUMONIA for 1888 per 10,000 living (of both Sexes) in certain AGE-GROUPS, during the FIRST FOUR WEEKS, and during the "EPIDEMIC" and "POST-EPIDEMIC" PERIODS respectively, in the ENTIRE DISTRICT and in each of the SANITARY DISTRICTS.

*First Four Weeks of the Year.**

—	Deaths from Pneumonia.						Rates per 10,000 living in each Age-Group.					
	0–	15–	45–	65 up.	15 up.	All Ages.	0–	15–	45–	65 up.	15 up.	All Ages.
Middlesbrough -	3	4	3	1	8	11	1·1	1·2	3·9	7·4	1·9	1·6
Ormesby - -	1	—	1	—	1	2	2·7	—	11·5	—	2·0	2·3
Normanby -	—	—	—	—	—	—	—	—	—	—	—	—
Eston - -	9	1	—	3	4	13	20·9	2·0	—	148·5	6·3	12·2
Entire District -	13	5	4	4	13	26	3·3	1·1	3·7	21·6	2·2	2·7
Epidemic Period.												
Middlesbrough -	20	117	115	33	265	285	7·2	36·2	149·4	243·2	64·1	41·2
Ormesby - -	—	10	2	3	15	15	—	25·7	22·8	194·8	30·5	17·3
Normanby -	6	15	12	4	31	37	16·7	34·2	125·1	285·7	56·5	40·8
Eston - -	9	13	7	3	23	32	20·9	26·2	60·1	148·5	36·4	30·1
Entire District -	35	155	136	43	334	369	8·9	34·0	127·2	232·1	57·5	37·8
Post-Epidemic Period.												
Middlesbrough -	26	20	25	2	47	73	9·3	6·2	32·5	14·7	11·4	10·5
Ormesby - -	—	2	1	—	3	3	—	5·1	11·5	—	6·1	3·5
Normanby -	5	5	3	—	8	13	14·0	11·4	31·3	—	14·6	14·3
Eston - -	3	1	1	1	3	6	7·0	2·0	8·6	49·5	4·7	5·6
Entire District -	34	28	30	3	61	95	8·6	6·1	28·1	16·2	10·5	9·7

* For comparison of this with the tables of the other two periods, the figures must of course be multiplied by 6.

From this Table M. it appears :—

1°. That, as regards the entire district, during the first four weeks of the year, the death-rate upon those over 15 years of age was not larger but less than that upon those under 15 (due, as will appear presently, to a high infant pneumonia mortality at Eston). The difference was most marked by far in the epidemic period, when the death-rate over 15 years of age was nearly $6\frac{1}{2}$ times that of the rate under 15 years. In the post-epidemic period the rate was one-fourth higher.

2°. That, again as regards the entire district, for all ages above 15 years there was during the first four weeks of the year and during the epidemic period, a progressively increasing death-rate with advancing age. But in the post-epidemic period it was otherwise ; for then the heaviest death-rate fell upon persons between 45 and 65 years of age (perhaps because those over 65 years who were susceptible of the fatal operation of the disease had been mostly carried off during the epidemic period). In the epidemic period the death-rate between 15 and 45 years was nearly four times that of persons under 15 years of age ; that between 45 and 65 years was about $3\frac{1}{2}$ times that of the persons between 15 and 45 years; and that over 65 years was about $1\frac{4}{5}$th times that of the persons between 45 and 65 years. In the post-epidemic period the death-rate between 15 and 45 was less than that of persons under 15 years; that between 45 and 65 years was about $4\frac{3}{5}$th that of persons between 15 and 45 years; and that over 65 years only a little over half that between 45 and 65 years.

3°. That these ratios of death-rates were not maintained equably in each of the districts.

Using the same method as was used in respect of the whole year (p. 190), we may inquire whether this distribution as to ages in each of the three periods of 1888 was the same as in previous years. For this purpose Table N. has been constructed.

Table N.

Entire District.

First Four Weeks of Year.

	Deaths from Pneumonia in Age-Groups.						Deaths in each Age-Group per cent. of Deaths at all Ages.				
	0-	15-	45-	65 up.	15 up.	All Ages.	0-	15-	45-	65 up.	15 up.
1888 - - -	13	5	4	4	13	26	50·0	19·2	15·4	15·4	50·0
1880–87 - -	54	30	19	7	56	110	49·1	27·3	17·3	6·4	50·9

Epidemic Period.

1888 - - -	35	155	136	43	334	369	9·5	42·2	36·9	11·7	90·5
1880–87 - -	233	235	188	57	480	713	32·7	33·0	26·4	8·0	65·9

Post-Epidemic Period.

1888 - - -	34	28	30	3	61	95	35·8	29·5	31·6	3·2	64·2
1880–87 - -	276	156	102	25	283	559	49·4	27·9	18·2	4·5	50·6

What we may note here, then, is that *during the previous eight years*, 1880–87, while the age-distribution of pneumonia was practically the same during the first four weeks and during the post-epidemic period, there was in the epidemic period distinctly some shifting of the incidence of the mortality from the ages of childhood to the ages above 15 years, and that this is observable in respect of each age-group. The increase of incidence was least between 15 and 45 years (viz., from 28 to 33 per cent.), greater between 45 and 65 years (from 18 to 26 per cent.), and again great above 65 years (viz., from 4·5 and 6·4 to 8·0 per cent.). This has been the rule with "pneumonia" as it was observed in the district prior to 1888.

Hence a *similar kind of shifting in* 1888, beginning to be observed when the epidemic commenced, and lasting through the epidemic period, was not outside previous experience. But what was outside the previous experience of the district was the much greater degree of the shifting, and the fact that it did not cease with the epidemic period, but continued, although to a less marked degree, through the post-epidemic period, and in this post-epidemic period was most strikingly obvious in the case of persons between 45–65 years of age, and partly by transference from those over 65 years of age.

All this will be made more apparent by limiting the comparison, as has been been done for the whole year (p. 191), to the distribution of the *deaths over* 15 *years*, leaving those under 15 years out of account: thus,—

		Deaths in each Age-Group above 15 years per cent. of all Pneumonia Deaths at 15 years upwards.		
		15–	45–	65 upwards.
First Four Weeks of Year	1888	38·5	30·8	30·8
	1880–87	53·6	33·9	12·5
Epidemic Period	1888	46·4	40·7	12·9
	1880–87	49·0	39·2	11·9
Post-Epidemic Period	1888	45·9	49·2	4·9
	1880–87	55·1	36·0	8·8

Here, again, it is seen that, notwithstanding the unusual incidence of the disease in the epidemic season of 1888 upon persons over 15 years of age, the distribution of the mortality among those over 15 years was, in that period, almost identical with that which has been customary in the district in previous years, and that the exclusion of the children from the calculation serves to bring into stronger relief the unusual post-epidemic incidence on persons between 45 and 65 years in 1888.

On the whole, then, it may be said that, as respects the ages of the persons who died, there was nothing unusual to the district in the pneumonia of 1888, except the unusually high incidence of the mortality upon grown-up persons of a certain age or ages.

Comparing now the age-incidence of fatal pneumonia in Middlesbrough in 1880–87 with that in England and Wales in 1881, we get data as follows :—

Table O.

England and Wales, 1881.

—	Population.						Deaths from Pneumonia.					
	0–	15–	45–	65 up.	15 up.	All Ages.	0–	15–	45–	65 up.	15 up.	All Ages.
M. - -	4,728,466	5,620,055	1,755,819	535,562	7,911,436	12,639,902	6,489	3,049	2,818	1,449	7,316	13,805
F. - -	4,740,125	5,989,617	1,951,713	653,082	8,594,412	13,334,537	5,477	1,732	1,469	1,219	4,420	9,897
M. and F. -	9,468,591	11,609,672	3,707,532	1,188,644	16,505,848	25,974,439	11,966	4,781	4,287	2,668	12,736	23,702

Middlesbrough District (excluding Eston), Eight Years 1880–87.

—	Population 1881.						Deaths from Pneumonia.						Rates in Eight Years per 10,000 living, in 1881.					
	0–	15–	45–	65 up.	15 up.	All Ages.	0–	15–	45–	65 up.	15 up.	All Ages.	0–	15–	45–	65 up.	15 up.	All Ages.
M. - -	14,377	18,320	4,257	657	23,234	37,611	249	261	193	48	502	751	173·7	142·5	453·4	730·6	216·1	199·7
F. - -	14,538	14,968	3,551	699	19,218	33,756	206	110	65	34	209	415	141·7	76·2	183·0	486·4	108·8	122·9
M. and F. -	28,915	33,288	7,808	1,356	42,452	71,367	455	371	258	82	711	1,166	157·4	111·5	330·4	604·7	167·5	163·4

England and Wales.

—	Pneumonia Death-rates in 1881, per 10,000 living.					
	0–	15–	45–	65 up.	15 up.	All Ages.
M. - -	13·7	5·4	16·0	27·1	9·2	10·9
F. - -	11·6	2·9	7·5	18·7	5·1	7·4
M. and F. -	12·6	4·1	11·6	23·3	7·7	9·1

Middlesbrough.

—	Mean Annual Pneumonia Death-rates of the Eight Years, per 10,000 living in 1881.					
	0–	15–	45–	65 up.	15 up.	All Ages.
M. - -	21·7	17·8	56·7	91·3	27·0	25·0
F. - -	17·7	9·5	22·9	60·8	13·6	15·4
M. and F. -	19·7	13·9	41·3	75·6	20·9	20·4

That the average annual rates for the Middlesbrough district here appear so much higher than the rate of England and Wales in 1881, is of course due to the rapid increase of the population of the district during the eight years: but this is not concerning us now. The point I wish to refer to now is that the distribution of the pneumonia mortality among the age-groups in Middlesbrough *in 1888* (see Table K., p. 190) was somewhat different from that in England and Wales in 1881 (the year selected for comparison) being 9 times higher at all ages together above 15 years, while it was only half as high again at ages under 15 years: it was 10 times higher at ages between 15 and 45 years, 13 times higher between 45 and 65 years, and about 11 times higher at 65 years of age and upwards.

As compared with the rates in Middlesbrough in previous years (so far as a comparison goes between the mean rates as given in the table just above and the rates for 1888 in Table K., p. 190); it would appear that the relative incidences of the total mortality on the several age-groups was little different in 1888 from what had been customary in previous years in Middlesbrough,—only slightly greater than was customary on the ages 45 upwards. This seems to confirm the inferences from Table L., p. 190.

We may gather, too, by a comparison of the figures in the tables just above given, that the distribution of the mortality among the adopted age-groups above 15 years of age was much the same during the eight previous years in Middlesbrough as in England and Wales in 1881, and that on the whole, so far as this comparison goes, the grown-up people in Middlesbrough were perhaps habitually more liable to suffer in excess of England and Wales than children were.

There is nothing, then, in the age-distribution to show that the pneumonia of 1888 differed from the pneumonia in Middlesbrough that occurred in former years.

Fatality, or Proportion of Deaths to Cases.

At the commencement of the inquiry I requested the medical officer of health of Middlesbrough to be good enough to obtain for my use, from the medical practitioners in the district, lists of cases of pneumonia that had come under their observation, marking the result of each case as to recovery or death. Most of these gentlemen made a return of some kind, but I found that few of them were able to give me complete lists; and there were but 12 of the lists that could be trusted as containing in each instance all the cases that had been attended by the compiler during the epidemic period. One of these lists was that of the medical officer of the workhouse. Selecting, then, these 12 lists, and excluding for special and separate investigation the list of workhouse cases, I found myself in possession of what I conceive to be a fairly accurate statistical record of the sex, age, date of attack, and result of 682 cases that came under observation during the 24 epidemic weeks, beginning on January 29 and ending July 14, 1888; as also of 103 cases of pneumonia which had been observed during three months preceding, —that is, between November 1, 1887, and January 28, 1888. From these lists I have constructed Table IX. (page 273), which shows the per-centage of deaths to cases, in each sex and in each of my adopted age-groups, during each four weeks of the epidemic period and during the epidemic period as a whole,—with the number of the cases which furnished the basis of the calculation throughout. Similar information is given as to the "pneumonia" of the preceding three months. The general upshot is to exhibit a fatality much greater than that which

"pneumonia" has of late years exhibited in the common experience of the medical profession. I propose to show this by reference to the statements of reliable medical writers. Unfortunately I have no means of comparing the fatality shown in Table IX. with the fatality of "pneumonia" observed in the same district during previous years. But the medical men that I conversed with recognised considerable excess of fatality in 1888.

1°. The fatality of the whole *epidemic* period *at all ages* and in *both sexes* together was 21·1 per cent.

Dr. Wilson Fox, in an elaborate and most carefully written article upon pneumonia in Reynold's System of Medicine (1st edition, p. 689), says: "Among the mass of statistical evidence on this subject, the "following table from Huss (p. 93) gives probably the most reliable "data." (I have added up the cases for a total at all ages) :—

Age.	No. of Cases.	No. of Deaths.	Per-centage.
5–10 - -	9	1	11·11
10–20 - -	229	14	6·11
20–30 - -	1,041	61	5·85
30–40 - -	816	97	11·88
40–50 - -	363	72	19·83
50–60 - -	127	27	21·60
60–70 - -	29	7	24·13
70–80 - -	4	2	50·0
All ages - -	2,618	281	10·7

Dr. Wilson Fox (*loc. cit.*, p. 686) says: "In 55 cases which I have "observed or collected from the case books of University College "Hospital and the North Staffordshire Infirmary, I have met with "eight deaths, but in all these the attendant circumstances were such "as fully to account for the mortality." He adds, however, in a note: "I do not present these as statistics of these hospitals, as I cannot feel "sure that they embrace all the cases admitted."

But the most remarkable experience is that furnished by that most accomplished physican and accurate observer, the late Dr. Hughes Bennett. In his "Clinical Lectures" (p. 698 *et seq.*) he has tabulated 126 cases of pneumonia, "positively all the cases of acute pneumonia "which have entered the clinical wards of the infirmary (Royal Infirmary "of Edinburgh) when under my care." He states that 105 of these were uncomplicated cases and that *not one of them died.* Of the 20 complicated cases only four died. Of all the 125 mixed cases (complicated and uncomplicated, as they would normally come into the hospital of a large city like Edinburgh) only 3·2 per cent. died.

Dr. Hughes Bennett attributes this extraordinary result in his cases to the adoption of the "restorative" plan of treatment, of which he was one of the pioneers, as contrasted with what has been termed the "antiphlogistic" plan (a depressing line of treatment) previously in common use, under which treatment the mortality at the Edinburgh Infirmary had been, according to Dr. Balfour (Brit. and For. Med. Chir. Rev., vol. xxii. p. 590), as high as 35·9 per cent.; whereas in Skodas' practice, by what has been termed the "expectant" method, the mortality was no higher than 13·7 per cent. But I must here observe that the treatment adopted by the medical practitioners generally in Middlesbrough was invariably of the "restorative" kind advocated by Dr. Hughes Bennett, and now commonly (I may say universally) practised in this country at the present time.

A statement of the fatality of pneumonia month by month and year by year for the 10 years, 1879 to 1888, as that disease was met with in the Cork Street Fever Hospital and House of Recovery in Dublin, has been kindly prepared and forwarded to me by Dr. Grimshaw, the consulting physician of the hospital, and Registrar General for Ireland. His table forms Table XIV. (p. 291). In the total there were 577 cases and 97 deaths, which gave a fatality of 16·8 per cent. The table is especially valuable, inasmuch as the cases were all such as had been mistaken for "fever" by those who sent them in, and they were all cases of "croupous" or "lobar" pneumonia, such as are ordinarily met with in a large city like Dublin. There are certain children's cases included, but only a small number. The figures, therefore, are admirably adapted for comparison with those in the Middlesbrough Tables IX. to XIII. The fatality of the Dublin cases varied in different years from 2·6 per cent. to 24·4 per cent., and, although there are some indications of a tendency for high prevalence and high fatality going together, the exceptions to this are numerous. Dr. Grimshaw has, in addition, given me the following statement:—"There are altogether eight hospitals in Dublin which "receive fever patients; all of them make returns to me each week, and "'pneumonia' is one of the diseases they specify. Two of these "hospitals, viz., Cork Street and the Hardwicke Hospital, are 'fever "hospitals.' They all receive a but comparatively small number of "children. I have made out for you a return for four years, showing "the number of cases of 'pneumonia' admitted, and the number of "these that were fatal. The total is 898 cases and 151 deaths, or "16·8 per cent. This is exactly the per-centage of deaths among the "10 years Cork Street cases." I am under much obligation to Dr. Grimshaw for the trouble he has taken to supply information, the more valuable because so recent.

I cannot, then, be in error in asserting that this Middlesbrough epidemic was of an *unusually fatal* character.

2°. As to the variations of fatality with the *age* of the subjects, we find from Table IX. (p. 273) that taking the two sexes together the fatality was in Middlesbrough during the six months of the epidemic period as follows:—

Ages	0–15 years	-	8·2 per cent. of cases.
„	15–45 „	-	20·9 „ „
„	45–65 „	-	37·1 „ „
„	65–upwards	-	43·3 „ „
All ages from 15 upwards		-	26·5 „ „

That there should be a variation in fatality with the *age* of the patient is no new experience. It has always been observed that the fatality of "pneumonia" increases with advancing age. The fact may be noticed in Huss' table on the opposite page. At ages, from 20 years upwards, however, the mortality in his cases was only 11·0 per cent. in contrast with the 26·5 per cent. from 15 years upwards in Middlesbrough, shown in Table IX.

3°. As to the fatality in the two *sexes*, Table IX. shows that, for *all ages together*, the epidemic was less fatal to females than to males, but that taking merely the ages over 15 years there was but little difference in the fatality in the two sexes—practically it was the same. This does not accord with the ordinary experience of pneumonia as shown by Dr. Wilson Fox. He says (*loc. cit.*, p. 689): "Pneumonia is a more fatal "disease to females than to males. Huss gives the relative mortality "as—males 10 per cent., females 14 per cent. The returns from Vienna "show the mortality to be as 2 to 3 in the male and females sexes, "so that although pneumonia is a less common disease in the female "sex, it is proportionally considerably more dangerous."

The relation of *age in the two sexes* to the fatality of the epidemic "pneumonia" at Middlesbrough was as follows:—

Ages	0–15	-	Males 10·6;	Females	4·8	per cent.	of cases.
„	15–45	-	„ 20·9;	„	20·7	„	„
„	45–65	-	„ 42·0;	„	25·0	„	„
„	65 upwards		„ 27·8;	„	66·6	„	„
„	from 15 upwards		„ 26·3;	„	27·4	„	„

It was only, then, in the age-group 65 upwards that the fatality was greatest among females. Of other ages it was either the same in the two sexes or least among females—most remarkably so among children. But in looking at the per-centages during the three months preceding the epidemic outbreak, we meet with some confirmation of Dr. Wilson Fox's statement that the fatality is ordinarily greatest among females, since during these three months of *non*-epidemic pneumonia the fatality among females was greater than among males, in the proportion of 22·9 females to 16·2 males. The epidemic was characterised by a change to a greater fatality among males than among females in the proportion of 22·4 to 17·4.

Dr. Wilson Fox adds to the passage quoted above: "His (Huss') " tables also appear to show that the mortality in the female sex is " less influenced by age than in the male." The Middlesbrough cases do not accord with this statement, for in *both* sexes the fatality was observed to increase with advancing age—and indeed (looking at the 27·8 per cent. among males at 65 upwards) apparently more certainly among females than among males. The most fatal age among males would appear from Table IX. to have been that between 45 and 65 and among females above 65 years.

4°. As to the fatality in relation to the *period of the epidemic*. Taking all ages and both sexes together, there appears to have been a tolerable uniformity of fatality through the whole six four-weekly periods, although it appears to have been somewhat greater at the beginning and end of the epidemic season than at other periods of it, and it was throughout higher than during the three months previous to the epidemic spread.

But looking at this point in respect of the several age-groups I have adopted, we find (Table IX.) that at *ages under* 15 *years* there was a most extraordinary fatality in the pneumonia during the first four weeks of the epidemic period. It was as great as 26·9 per cent. of the cases. The fatality fell in the second four-weekly periods to 2·9, after which it varied from 5·3 to 7·7. And it is to be observed further that during the three months preceding the epidemic outburst it was as high as 17·0 per cent. From Huss' table (p. 196) we may gather that his fatality at ages under 20 years was 6·3 per cent. of the cases. Ziemssen's mortality, according to Wilson Fox, was in the case of children less than 4½ per cent. As respects those *over* 15 *years of age* the fatality of both sexes together was at the outburst of the epidemic 21·1 per cent. It had been high (19·6 per cent.) during the previous three months, but it rose subsequently to 29 per cent., falling later on to 26 and 27 per cent. It was not at its highest at the time of the greatest prevalence of the disease and of the greatest pneumonia mortality in the district (viz., the month ended June 16), nor was it so in any of the adopted age-groups. One thing remarkable is that whereas at ages 15 to 45 the fatality obviously lessened towards the latter part of the epidemic, at ages above 65 years it still more obviously increased, and this most remarkably in the male cases.

In Table IX. I have excluded the cases belonging to the district which were treated in the union workhouse, but if we include these the per-centages of fatality arrived at are as follows (Table P.):—

Table P.

Showing the Per-centage of Deaths upon Cases treated by Eleven Medical Practitioners and in the Union Workhouse together.

Ages.	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
November 1, 1887, to January 28, 1888.	11·1	22·7	= 16·3	20·7	18·2	= 20·0	29·4	—	= 25·0	100·0	66·6	= 80·0	27·1	23·5	= 26·2	21·3	23·3	= 21·9
1888. January 29 to February 25	28·0	—	= 24·1	23·8	22·2	= 23·3	45·5	—	= 33·3	—	100·0	=100·0	31·2	21·4	= 28·3	29·8	16·7	= 27·2
February 26 to March 24 -	—	7·7	= 2·4	23·8	66·6	= 26·7	56·2	16·7	= 45·4	25·0	—	= 25·0	32·3	33·3	= 33·8	22·2	18·2	= 21·4
March 25 to April 21 -	8·7	—	= 5·7	19·5	31·2	= 21·9	44·4	20·0	= 37·8	33·3	33·3	= 33·3	27·6	27·6	= 27·6	23·6	19·5	= 22·5
April 22 to May 19 -	8·3	5·0	= 6·2	28·6	17·6	= 26·0	43·5	28·6	= 40·0	28·6	100·0	= 44·4	32·6	23·1	= 28·6	27·3	13·6	= 22·2
May 20 to June 16 - -	4·5	5·3	= 4·8	20·3	11·1	= 19·3	40·0	42·9	= 40·6	54·9	75·0	= 60·0	27·8	35·0	= 28·9	24·1	20·5	= 23·3
June 17 to July 14 - -	11·1	—	= 6·7	22·2	12·5	= 20·5	60·0	50·0	= 55·5	100·0	50·0	= 75·0	30·2	28·6	= 29·8	27·5	20·0	= 25·0
Total of 6 epidemic months	9·9	4·3	= 7·6	22·7	22·6	= 22·7	45·8	26·3	= 40·7	44·4	66·6	= 51·3	29·9	28·6	= 29·6	25·2	17·4	= 23·1

In this table the per-centages of fatality are generally higher than in Table IX., except at ages under 15 (and this probably because there was in the workhouse a much smaller proportion of children under five years of age); but there is a similar disproportion between the male and female fatality in the two tables. As regards the fatality at different periods of the epidemic, but little alteration is introduced by including the workhouse cases; but the increase of fatality at ages above 65 years as the epidemic progressed is seen to be accentuated.

In some parts of the town of Middlesbrough, and especially in some more limited areas, particularly to the north of the railway, the fatality of the cases was very much higher than the statistical tables above given would indicate. The way in which, in Middlesbrough town, as well as in other parts of the infected district, pauper practice, club and contract practice, and private practice are intermingled, and the imperfection of several of the lists of cases furnished me by medical practitioners render futile any attempt to represent in a statistical form the extreme fatality I am alluding to; but the fact was strongly impressed upon my mind in the course of the inquiry. Some notion of excessive fatality of the magnitude referred to may be gathered from particulars I shall have to record when the subject of multiple cases in a house comes to be dealt with at a later period of the report (p. 226 and Table XV., p. 292).

Number of Cases of "Pneumonia" during 1888 *in the Entire District.*

The number of cases in the entire district can only be estimated satisfactorily (and for the 24 epidemic weeks only), upon the rates of fatality of the disease observed in the practices of the eleven medical men whose cases are recorded in Table IX.; for it is requisite to exclude the workhouse in which, as will be seen presently, the fatality of the disease was excessive.

The following table represents the results of the calculations made upon this basis:—

Table Q.

Ages.	Estimated Population.	In Epidemic Period.			
		Deaths from Pneumonia per cent. of Attacks.	Number of Deaths.	Number of Cases probably represented by these Deaths.	Cases per 1,000 of estimated Population.
Under 15 years -	39,524	8·2	35	427	10·8
15 and under 45 -	45,535	20·9	155	741	16·3
45 „ 65 -	10,694	37·1	136	366	34·3
65 years and upwards -	1,853	43·3	43	99	53·4
15 years and upwards -	58,082	26·5	334	1,206	20·8
All ages -	97,606	21·1	369	1,633	16·7

It will be seen from the above table how the *liability to attack* by the disease increased with age, and especially how rapidly it increased at ages above 45. For anything that I know to the contrary, this may be a common rule in pneumonia.

Clinical Characters of the Disease.

Through the courtesy of some of the medical practitioners in the district opportunities were given me of seeing certain of the cases under their care in one or another stage of the disease; and although in many of these cases I was able to gather important particulars of the attack, I

had not the time to visit them regularly or systematically. But the medical gentlemen referred to kindly supplemented my own observations, and gave me in detail the result of their observations in the course of the epidemic. In most pneumonia cases the invasion was sudden, sometimes while a man had been at work, but often an hour or two after he had gone to bed. In other cases the patient had been feeling out of health in one way or another for periods of a day or two, a week or even a fortnight. Almost invariably the attack commenced with shivering, technically termed a rigor. Usually this initial rigor was the only one experienced, but now and then it recurred in the course of the first day or two of the illness. Some of the medical practitioners told me that the rigor (essentially a convulsive affection) now and then passed into actual convulsion. Dr. Bateman, one of the district medical officers of Middlesbrough, who had during the epidemic a very large number of cases under his care, told me that there were epileptiform convulsions in two of his adult cases (in one of these about 12 hours after the commencement of the illness), and that one child aged 2 years died in a convulsion. Another very early symptom was pain referred to one or the other side or to the epigastrium, now and then to the loins. The pains usually commenced at the same time as the rigor, but now and then preceded it. Very rapidly after the rigor or commencement of pain, the bodily temperature rose, sometimes so rapidly as to reach 104° Fahr. in a few hours. The highest temperature I have on record on the charts is a morning temperature of 105° Fahr. (Case XXX., p. 311) on the third day of the illness. With this febrile condition there was a rapid pulse, which became small as the illness progressed, and rapid respiration; and usually there was early in the case considerable nervous prostration. The skin was mostly perspiring in the cases I saw and at the time I saw them, but in nearly all these cases the chest has been enveloped in large linseed poultices. In no case did I observe sudamina, and in only one instance did I observe any herpetic eruption about the mouth. Cough was not usually a very striking feature. In some few cases there was none or almost none. It was in no case troublesome, as it in bronchitis. The expectoration was usually yellowish at first, and scanty, then presented the characters of rustiness and tenacity common to pneumonia, and later on assumed in some cases the "prune-juice" character. More or less gastro-intestinal disturbance was often present. This disturbance was mostly manifested by vomiting or diarrhœa, or by both. Not uncommonly one or the other of these, but mostly vomiting, was among the earliest symptoms of the illness, accompanying or following shortly after the rigor or pain; sometimes one or both occurred a little later, and in either case they sometimes recurred or persisted during a few days. In the fully-developed cases, the tongue was usually dry and brown, with white-coated usually moist edges. Delirium sometimes violent, usually consisting in rambling talk or constant endeavour to get out of bed and go downstairs, was an almost invariable symptom in one or another period of the illness. It sometimes occurred very early, viz., on the first day, but usually on the second or third day of illness. In one case (Case IV., p. 301) it appeared to have accompanied the initial rigor in a sudden seizure. The physical signs of pleuro-pneumonia were ordinarily observed. In some cases the signs of the more advanced stages occurred very early; in others the distinctive signs were tardily developed, and were not very obvious at any period of the illness, the signs then consisting merely of exaggerated breath sounds or possibly of a little dulness on percussion, harsh breath sounds, and perhaps some dry rhonchi. But for the most part it was otherwise, and by the second day of illness marked dulness with tubular breathing and more or less loud friction

sounds were observable. But what much struck me was that in many cases the constitutional disturbance was out of all proportion to the evidence of local pulmonary disease. Case IV. (p. 301) is one illustration of this, and I saw plenty of others. Indeed *towards the close of the epidemic* the medical men of the district were nearly daily telling me of such cases. The attacks had commenced with their customary suddenness and violence, but the disease seemed to become abortive, and the patient was comparatively well in a few days.

The pleuro-pneumonia was either single or double. I cannot say that either in this respect or as regards limitation to an upper lobe it differed markedly from pneumonia as commonly observed. The *duration* of the illness varied. In a good many fatal cases death occurred on the third to the fifth day of illness, not many of them were much more than a week's duration from the day of rigor. In cases destined to recover, a crisis was usually noticed to occur on the seventh to the tenth day, when the temperature rapidly fell to normal, and with this fall in temperature there was improvement in the condition of the patient generally. [See series of temperature charts at end of Report.] From this time the cases generally went on uninterruptedly to recovery, but in some cases *relapse* occurred. Sometimes this relapse might be accounted for by some indiscretion on the part of the patient, but in other instances the cause of the relapse was not thus traceable. Case XXVII. (p. 310) is an illustration of this occurrence. The temperature chart No. 12, also refers to a relapsing case that was observed in the North Riding Infirmary. I myself saw others. A case of this kind occurred in the practice of Dr. Cook. The man was a cowkeeper and farmer; he had been in bed with "pneumonia" for 16 days and was recovering satisfactorily, but on the 19th day he went out on to his farm, had a fresh attack (double pneumonia), during which attack I saw him, and he died from it. Several other cases of relapse, some of which were fatal, have been communicated to me by the medical practitioners. The relapses seem to have occurred mostly three or four days after convalescence had appeared to have set in, or from the 12th to the 19th day from the initial rigor. A fresh rigor ushered in it.

In all that has been written above as to the symptomatology of the Middlesbrough malady, there is little or nothing in which this epidemic pneumonia differed materially, except perhaps in the early prostration, from "pneumonia" as ordinarily met with in the medical practice of this country. But I am now about to mention some occasionally observed phenomena, some of which were (so far as my memory serves me) new to my experience, or are only cursorily alluded to in the several standard works on medicine that I have consulted, and others of which are not alluded to at all as accompaniments of an attack of pneumonia. First, as to *hæmorrhages*. I have a note of one case in which profuse hæmoptysis occurred on the second day of illness. It continued on and off for three days, and had to receive special treatment with a view to its arrest. But this hæmorrhage, of course, may have been due to tuberculosis. I have notes of several instances in which epistaxis occurred, and have been informed by several of the medical practitioners of its occasional occurrence in their several practices. Dr. Wilsox Fox (*op. cit.*, p. 652), when speaking of doubtfully critical phenomena, just mentions epistaxis as being observed occasionally. Dr. Eustace Smith, in his work on "Disease in Children," does not mention it at all in connexion with pneumonia. Mr. Longbotham, the medical officer of the Middlesbrough Workhouse, informs me that among the cases he treated in the workhouse infirmary there were four which had epistaxis; two of these cases were children who had free epistaxis on about the third day of illness; both of them

recovered. In one of his adult cases he regarded the epistaxis as critical. It occurred at a time when the disease was fully developed, and it was so severe that he had to plug the nares. From that time convalescence set in and the man recovered. Dr. Veitch told me he had had three cases in which epistaxis had occurred; one of them was an adult; the epistaxis occurred on the third day of illness, and the patient died on the seventh day. The other two cases were in children; the epistaxis occurred on the third or fourth day: both children recovered. Among the memoranda of cases given me by Dr. Bateman I find two instances of epistaxis, one in which it occurred on the fifth day, and the other (in which there was intense headache) in which it occurred three days in succession. Both these cases ultimately recovered. Dr. Ketchen also informed me that he had seen several instances of epistaxis occurring during the course of the illness, but in no case was he able to regard it as critical. I have received accounts of three instances of hæmatemesis, all of them towards the close of the illness, and all three of the cases were fatal. One of these cases was Case XIV. (p. 306), under the care of Mr. Longbotham. A second was under the care of Dr. Craster and Mr. Longbotham. Mr. Longbotham informs me that blood was vomited twice, the first time the day before death; the second vomiting of a few tablespoonsful of blood occurred on the day of death, and the patient lived only a few hours after this second vomiting. The third instance occurred in the practice of Dr. Craster. The patient was taken ill on May 28 and died on June 1 (the fifth day), and like Case XIV., vomited the blood almost in the act of death. I am assured by these gentlemen that these were not instances of epistaxis in which the blood from the nares had been swallowed. I may refer in this connexion to the account of the autopsy on Case XXVI. (p. 309). Another class of occasional phenomena occurring in the course of the pneumonia that should be mentioned, is painful rheumatic-like swelling of the joints, notably of the knees and ankles. This was observed in certain cases. In this connexion, see fatal Case XXVI. (Appendix).

Various *sequelæ* were occasionally observed and were sometimes fatal. Those of which I have memoranda are the following:— Empyema, two cases; apoplexy, two cases. One of the apoplectic cases was in Dr. Jas. Glen's practice. The man, aged 55, was attacked with pneumonia on May 6. He recovered, but died of apoplexy after two days illness on June 9. The other was in Dr. Young's practice. A woman, aged 56, was attacked on Feb. 25; recovered, but died of apoplexy on March 29. "Rheumatism" (so termed) in one case, retarded convalescence. Abscess in the ankle in one case. Abscess in the back in one case. Plugging of the saphena vein, and death at a later period from abscess in the lung in one case. Disorganisation of the eyeball and meningitis, Case XXXV. (p. 314). Synovitis (Temp. Chart No. 9). Plugging of the femoral artery (Temp. Chart No. 11). There can be little doubt that most of these sequelæ were the result of embolism. I do not find in the standard works I have consulted any account of sequelæ of pneumonia.

Pathological Characters of the Disease.

Up to the time of my commencing the inquiry at Middlesbrough no post-mortem examination of any person dead of the epidemic malady had been made. But during the two months I remained there the local medical men did all they could to procure for me opportunities of investigation in this direction. The results of 12 examinations made by myself, or which were made at my request, are given at pp. 299 *et seq.*

(Cases I., II., III., VI., VII., X., XI., XIX., XXVI., XXVII., XXXIII., XXXIV.). The following statement may be regarded as a general abstract of them :—The post-mortem lividity was very marked, of deep tint and usually extended over the lateral and even sometimes beyond the lateral parts of the trunk and limbs. I do not think this is unusual in bodies dead from pneumonia. In only one instance, Case I. (p. 299), was there evidence of any recent pericarditis. The *right* cavities of the heart and the large vessels proceeding from it were in most cases fully distended with blood clot, from which fibrin had separated more or less, forming a tough material which adhered more or less to the muscular columns, especially of the ventricle, in such a way as to require some force to detach it. The firm fibrinous material was continuous with the clot that lay in the pulmonary artery and its main branches. This separation of fibrin was more certainly found in the right ventricle and pulmonary artery than in the right auricle. In four instances the *left* cavities of the heart were empty of blood or nearly so, but in most they contained a clot which was usually highly fibrinous, indeed almost entirely consisting of a tough fibrinous material which mostly adhered firmly to and was entangled among the fleshy columns and trabeculæ, and extended into the aorta and its main branches. In Case XIX. the body was examined when recently dead, and while yet quite warm, and here, while the blood on the left side had not yet coagulated, a fibrinous clot was found in the pulmonary artery, and moulded into the irregularities of the right ventricle. The blood within the heart was found fluid in this case on the left side : it was also found fluid in another case where the body was examined only 1½ hours after death (Case VII.), and in a third case (Case X.) where the man had been drinking hard for a week, but where the body was examined 17 hours after death. In one case (Case XXVII.) there were evidences of recent ulcerative endocarditis. In all but one case (X.) there were evidences of more or less severe recent pleurisy,—either on one side or on both sides according as the pneumonia has been single or double,—consisting in effusions, mostly abundant effusions, of lymph, and of more or less liquid matter. In all the cases there were evidence of pneumonia on one or both sides. In only two had the stage of grey hepatisation been fully reached (Cases XXXIII. and XXXIV.). In one (Case I.) part of one lung was found to be passing into this condition. Otherwise, in most of the cases there was found in one or both lungs the condition of red hepatisation. In other cases this stage appeared not fully arrived at. Generally speaking, throughout the series there was on section an abundant flow of red serosity, sometimes frothy and sometimes not frothy, from any part of the lung that felt firmer than normal on handling, the serosity either following the knife or exuding on slight pressure. Another thing was the particularly dark red colour of the cut surfaces where grey hepatisation was not observed. In Case XI. the colour was so dark that the parts of the lung which were not hepatised and friable looked hæmorrhagic ; and in Case I. some apparently hæmorrhagic spots were observed in the lung tissue. In none of the cases was there any evidence of tubercular lesion, old or recent. In all these abnormal conditions of the lungs or pleura there is nothing absolutely distinctive,—nothing that has not been observed before in ordinary cases of fatal pneumonia. The condition of the liver varied ; it had the nutmeg character, or it was congested, or was pale or normal, but presented no condition other than may be met with in any case of pneumonia. The spleen was in nearly all cases either soft or absolutely pulpy. The kidneys were in only one instance found to be apparently normal, but the pathological condition varied in character : it presented nothing distinctive of

this particular form of pleuro-pneumonia. The stomach in all cases presented more or less of an ecchymosed condition of the mucous membrane, this appearance being mostly observed about the small curvature. In some instances this was very marked, and more so than I think is common in ordinary cases of pneumonia. In one instance (Case XXVII.) a quantity of what appeared to be partially digested blood was found in the stomach. Other morbid conditions of the mucous membrane were also observed. The intestines were in a normal condition. In all these naked-eye observations there was nothing that has not been observed and more or less distinctly described by authors as occurring in the bodies of persons dead of the ordinary pneumonia of this country, unless perhaps I except the sometimes unusual amount of ecchymosis observed in the gastric mucous membrane.

From every one of the bodies of persons dead of "pneumonia" examined by myself personally, or by Dr. Malcomson or others,—in my place and at my request when I could not be present myself, portions of diseased lung and of other organs hardened in spirit (and in nearly all instances portions also of fresh lung wrapped in gutta-percha tissue placed in a stoppered bottle) were despatched immediately, to Dr. Klein for detailed pathological examination. In one instance (Case VI.) Dr. Klein himself, before the body was opened, extracted what fluid he could from the cavities of the heart. Dr. Klein's report upon his investigations is given in full in Addendum (B.) to this report (pp. 314–326). It may suffice, therefore, in this place to state only his more important pathological results. He says :—

"Microscopical examination of fine sections of hardened and inflamed "pieces of the lung showed that the alveoli were filled with exudation. "This consisted of a fibrinous or amorphous granular substance, and "in it were numerous leucocytes along with epithelial cells swollen and "detached. Different alveoli in the same and in adjoining lobules "differed from one another in the number of leucocytes enclosed "within the fibrinous and amorphous exudation; but I have not been "able to find red corpuscles in any appreciable number in the exudation, "such as are constantly present in red hepatisation. Although the pieces "of lung under consideration had the general character of a croupous "lung in the stage of red hepatisation, I can find leucocytes, and but "occasional red corpuscles, in some few alveoli. The capillaries in the "alveolar walls were much engorged, so were also the large vessels "leading into or from them; in the inter-alveolar tissue there were "numerous leucocytes, but they were not uniformly distributed, since "they were absent from one part of a lobule while numerously present "in another part."

"As to other viscera examined :—in sections through the *liver*, all the "liver cells were found in a state of pronounced opaque granular "swelling; in some places these cells showed granular disintegration, "in others they were filled with fat droplets. In the *kidney* there was "slight glomerulo-nephritis; many of the convoluted tubes showed "cloudy swellings, and in a few straight tubes of the medulla hyaline "casts were seen."

But the most important discovery made by Dr. Klein was that of a hitherto undescribed *bacillus* which he found in the fresh lung juice. He says :—"Microscopical examination of this lung juice in a fresh state "revealed the presence in it of short bacilli, singly and in dumb-bells, "with here and there a bacillus (single or dumb-bell) possessed of "active movement, spinning round and round with great velocity, or "darting backwards and forwards across the field of the microscope in "various directions. The number of such motile bacilli was very small, "but in size and aspect they did not appear to differ from the others."

"Cover-glass specimens prepared after the Weigart-Koch method "from the same lung juice showed, after staining with gentian violet, "bacilli also, but in varying numbers . . . They were apparently "of one kind; oval rods rounded at the ends, and arranged generally as "dumb-bells, though in some cases a chain of three or four short rods "could be detected. Each rod of the dumb-bell was now and again "constricted in the middle. When a cover-glass preparation is well "washed, the rods show at each end a deeply-stained part, the middle "portion remaining of a faint colour, after a fashion which in former "years was considered characteristic of bacterium-termo. As regards "length and thickness, the majority of these microbes are also com- "parable with bacterium-termo, being only twice as long as they are "thick; but there is no difficulty in finding amongst the several "single and dumb-bells forms, rods of such length as indicates that "they are bacilli. And examination of cultivations of the organism "further proves this."

The bacillus described by Dr. Klein was, for a reason he assigns, very difficult of detection *within the diseased tissues*, but they were nevertheless detected, not only in the contents of the alveoli, but in the inter-alveolar tissue also. They were also found to be present in the fresh sputum of the sick.

Dr. Klein has failed to see anything that would indicate spore-formation in these bacilli, and experiment seems to him to confirm his other observations as to the absence of spores. It is further worthy of remark here that complete desiccation or exposure for five minutes to a temperature of 75° C. (167° Fahr.) alike suffice to kill the bacilli.

The results of cultivations and of experiments on animals are fully given in Dr. Klein's report. His general conclusions are as follows:—

"1. In the diseased lung of the Middlesbrough pneumonia cases, "there were present in large numbers short bacilli, that are not "Friedländer's bacillus nor the diplococcus pneumoniæ of Fränkel and "Wiechselbaum, but which, upon cultivation and inoculation into "rodents, appear to be a definite species distinctly different from "either; I therefore call this bacillus the *Bacillus Pneumoniæ*.

"2. Neither Friedländer's bacillus nor the diplococcus pneumoniæ "of Fränkel and Wiechselbaum was obtainable from this human "pneumonic lung by cultivation.

"3. The lung juice of this pneumonia when inoculated into guinea- "pigs, and especially when inoculated into mice, produced an acute "disease, of which the chief and constant anatomical lesion was severe "inflammation of the lungs. Mice were more susceptible than guinea- "pigs.

"4. Artificial cultivation of the "bacillus pneumoniæ" from the "human lung or from the blood of an experimented mouse proved "very virulent to mice, less so to guinea-pigs. In mice these bacilli "produced the same fatal disease as mentioned above, with conspicuous "pneumonia.

"5. The blood and lung juice of mice and of guinea-pigs dead of "the disease experimentally induced by materials from the several "above-recorded sources, produced on inoculation into other mice and "guinea-pigs severe pneumonia terminating fatally.

"6. In all experimented animals dead of the induced disease, the "lung juice (in mice also as a rule the heart's blood and the spleen) "contained the 'bacillus pneumoniæ.'

"7. By feeding mice with artificial cultures of the bacillus, the same "pneumonia was produced, but not in so large a proportion of "experimental animals as by inoculation."

Nosology.

This appears the proper place for stating briefly what to my mind is the precise position in a classification of diseases for this Middlesbrough epidemic disease. Whatever view may be taken of other forms of pneumonia with which this Report has no direct concern, *this particular form* is distinctly not a local but a general disease, it is a *specific fever* marked like other specific fevers by certain definite local characteristics. Like them it would seem to possess the quality of communicability from the sick to the healthy, either immediately through proximity or mediately through food or otherwise. It has seemingly its own specific *contagium vivum*, the "bacillus pneumoniæ" of Klein, which has been captured, isolated, and duly studied. To this particular form of so-called (croupous) pneumonia applies all that I have printed in italics in the following extract from a classical work on pneumonia by Dr. Octavius Sturges.*

"It is both a local inflammation and a special form of fever. As an inflammation it is remarkable for the distinct stages it undergoes, for the deportment of its histological elements, for the preservation of structural integrity amid changes which in other circumstances imply permanent damage. *As an affection of the general organism it is no less remarkable for a sudden access of pyrexia whose character and duration are not measured by the lung mischief, and whose time of departure, occurring within a set time, irrespective of recovery on the part of the lung, is equally sudden and characteristic. If the pyrexia is symptomatic, why is it not a truer index of the inflammation that provokes it?* If, on the other hand, the lung affection is no more than a symptom of a specific fever, whence does this fever arise; how, with such unexampled suddenness, should mere exposure suffice to produce it in a healthy body?" (Page 63.)

"*Its place among diseases.*—Pneumonia thus occupies a middle place between the specific fevers so called, and the local inflammations, and has something in common with both. It falls short of the one by wanting the material of infection and a period of incubation, it exceeds the other by *possessing the character of orderly pyrexia and definite duration. It is not a fever which, apart from any fixed seat, pervades the system generally, like typhus, and, in default of definite lesion, is laid to the charge of the blood, neither is it a mere pyrexia, the immediate response to a local inflammation. For its full recognition* (*I would not say for its essential existence*) *lung inflammation is necessary*, but the presence of such inflammation by no means implies or secures the presence of pneumonia. At one time it will present, almost exclusively, the characters of a local disease, at another, chiefly those of a specific poison. By its aspect, its duration, and concomitant lesions, as well as by the special characters it acquires in certain epidemic constitutions, it would seem most like fever; in its actual histology, the class and circumstance of persons amongst whom it obtains, and the absence of any extraneous material cause, it is most like an 'idiopathic' inflammation. And this position of isolation between distinct classes of diseases is further secured to pneumonia by the fact that, in the best instances of the disease, the lung itself does not actively participate in the changes that occur within it, that in yielding directly from the blood a material destined to be removed from the system without injury to the organ that receives it, the

* Natural History and Relation of Pneumonia. A clinical study. By Octavius Sturges, M.D. 1876.

pneumonic process is in fact special and *sui generis*. As such let it be judged of by itself, less by comparison and analogy, which may be forced and misleading, than by endeavouring to trace from the pattern of nature its own proper history in various circumstances, careless whether, in the delineation, we are producing a picture in harmony with preconceived notions of what the thing ought to be." (Page 178.)

I give these extracts in their entirety for two reasons; first, because the truly logical nature of Dr. Sturges' argument upon the basis of then knowledge claims recognition; and secondly, because the passages indicate to my mind, and I think they will indicate to the minds of others, that Dr. Sturges' hesitation as to the precise place in a nosological classification that pneumonia should occupy may be due to there really being various kinds of (croupous) pneumonia; or perhaps, to speak more correctly, due to croupous pneumonia as met with in hospital practice being the local manifestation of more than one febrile disease. In fact that in common parlance there are pneumonias and pneumonias. Most recent writers on pneumonia of any eminence speak with more or less hesitancy as to the specifically febrile nature of croupous pneumonia. Ziemssen, however, speaks decidedly about it. He says it is a specific disease. Some of Dr. Sturges' difficulties (confining my remarks here to the Middlesbrough disease) appear to be swept away by the discovery of Dr. Klein's bacillus pneumoniæ, and what I shall show (p. 239) to be the true position of exposure to chills, &c. in the causation of the malady in individual cases.

Without expressing, then, here (since I have no occasion to express it) any opinion that I may hold as to the proper place for croupous pneumonia (using the term generically) in a natural classification of diseases, I have no scruples whatever in claiming for the disease it was my privilege to observe in Middlesbrough a place,—with typhus, enteric, and relapsing fevers,—among the specific fevers, and in designating *it* from its local characteristic "Pleuro-pneumonic fever,"—removing it indeed altogether from the class of local diseases.

"Epidemic" pneumonia and pneumonia arising in association with filthy surroundings (a form of pneumonia described by Drs. Grimshaw and Moore,* to which they have given the name of "Pythogenic Pneumonia,") are by no means new in the experience (old and recent) of the medical profession.

The outbreak at Nantes alluded to at pp. 164 and 238 of this Report is an example of epidemic pneumonia, and there are plenty of other instances,—on various scales of importance, recorded in the literature of the profession, and in annual reports of Medical Officers of Health which are in the hands of the Board,—in which, on grounds more or less valid, communicability from the sick to the healthy of the current malady has been ascribed as a characteristic of the epidemic. Into the details of these instances it is impossible here to enter. But it by no means follows that the outbreaks described by others were instances of the same disease that I observed at Middlesbrough, or that they were due to indentically the same bacillus or contagium vivum. There may be many such contagia viva—several kinds of micro-organism—capable of setting up a specific croupous pneumonia—a true pleuro-pneumonia fever, which may indeed be in some forms contagious, in other forms non-contagious. The subject is matter for future investigation.

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* Dublin Medical Journal, May 1875.

In studying the causation, the mode of origin, and the mode of spread of this epidemic pneumonia, I had a most difficult task before me. I saw this when I was originally charged with the inquiry; and the difficulty lay first in the fact that up to this time, so far as I am aware, no similar investigation of so extensive an epidemic of pneumonia had ever before been undertaken, and therefore I had nothing to guide me but my experience in tracing to their cause or causes epidemic outbreaks of other kinds of disease;—either of common diseases such as enteric fever and scarlet fever, or of uncommon diseases such as the Welbeck epidemic of choleraic diarrhœal disease. It was upon these experiences that I had mainly to trust; I looked to them to guide me, and I took also into account, in order to test their validity (as every etiological investigator is in my opinion bound to do), the current popular notions, whether professional or otherwise, which I found to be held upon the subject. If he had neglected to follow this practice, Dr. Jenner would never have given to the world his grand discovery of vaccination as protective against small-pox. These notions were the following:—Some, and indeed I may say the whole, of the labouring population held that the epidemic was a *new* disease, which had its origin in the inhalation of a particular kind of dust arising from a new process recently established at Middlesbrough, namely, the pulverisation and sifting of the slag from the converters in which iron is made into steel by the Gilchrist-Thomas process. Others, and with them a majority of the medical practitioners in the district, attributed the epidemicity of the pneumonia to the extraordinary character of the season, to a remarkable prevalence of easterly winds, and to the fogs and consequent dampness of the atmosphere which resulted from the emanations of marsh land lying along the south bank of the Tees to the east of Middlesbrough. Some of the medical practitioners whom I interviewed on my arrival at Middlesbrough felt sure, while others said they had reason to suspect, that the disease was communicated directly by infection from person to person; but the instances they adduced in support of their beliefs were not such as to be conclusive on the point, being such as might be explicable in other ways. These were the three principal notions I found abroad. No pathological investigations had been made. This was in a degree excusable, looking at the popular repugnance to this kind of investigation among the class of persons who form the large majority of the inhabitants of the district. It was with difficulty that I was enabled to make this first step towards the inquiry into causation. The result of the pathological investigation has already been placed on record, and in its proper place I shall consider its bearing upon the question of causation.

In proceeding to discuss the etiology of the epidemic disease, I shall not follow the precise order in which I have mentioned above the several points which have to be considered, but adopt an order which appears for present purposes more convenient.

1. *Relation of the Epidemic to Season of the Year.*

The first remark that has to be made under this head is that the epidemic prevailed at the customary *season* of pneumonia prevalence (as indicated by mortality tables) in this country, indeed at the season when for the previous eight years it had been most prevalent (again as shown by mortality tables) in Middlesbrough and its neighbourhood. It may suffice in evidence of this to introduce here a table constructed from the "Weekly Returns of Births and Deaths in London," issued by the Registrar-General during the nine years 1880 to 1888. (Table R.)

Table R.

Total Deaths, at all and at certain specified Ages, from "Pneumonia" registered in London during Nine Years, 1880 to 1888,* distributed into 13 Four-weekly Periods; and similarly the London Pneumonia Deaths in 1888.†

Total Deaths during Nine Years, 1880 to 1888.				Deaths during 1888 alone.		
Four-weekly Periods.	Under 5 Years.	5 Years and upwards.	All Ages.	Under 5 years.	5 Years and upwards.	All Ages.
1st	× 1,941	× 2,005	× 3,946	× 260	× 295	× 555
2nd	× 2,118	× 1,988	× 4,106	× 219	× 287	× 506
3rd	× 2,015	× 1,883	× 3,898	× 212	× 275	× 487
4th	× 1,851	× 2,046	× 3,897	× 197	× 276	× 473
5th	1,559	× 1,776	× 3,335	131	× 214	345
6th	1,258	1,437	2,695	115	180	295
7th	1,156	1,145	2,301	117	123	240
8th	1,096	853	1,949	133	85	218
9th	921	841	1,762	119	89	208
10th	951	989	1,940	115	102	217
11th	× 1,744	1,378	× 3,122	× 231	162	× 393
12th	× 2,121	× 1,571	× 3,692	× 214	133	347
13th	× 2,010	× 1,727	× 3,737	× 216	157	× 373
Means	1,595	1,511	3,106	175	183	358

* There was nothing approaching an epidemic of pneumonia in London taken as a whole during these nine years.

† The mark × is placed against numbers in *excess* of the mean number.

The following table is introduced for comparison with the above:—

Table S.

Showing for Middlesbrough and the Three Local Board Districts included in the Inquiry the Total Deaths, at all and at certain specified Ages, from "Pneumonia" that occurred during the Eight Non-Epidemic Years, distributed into Four-weekly Periods, and similarly, particularly for 1888.*

Total Deaths during Eight Years, 1880–1887.				Deaths in 1888.		
Four-weekly Periods.	Under 5 Years.	5 Years and upwards.	All Ages.	Under 5 Years.	5 Years and upwards.	All Ages.
				†	†	†
1st	× 43	67	× 110	× 11	15	26
2nd	× 37	× 77	× 114	× 7	28	35
3rd	34	× 98	× 132	× 6	× 51	× 57
4th	27	× 96	× 123	3	× 48	× 51
5th	22	× 88	× 110	5	× 60	× 65
6th	36	× 95	× 131	× 7	× 99	× 106
7th	36	67	103	2	× 53	× 55
8th	30	29	59	3	17	20
9th	26	42	68	4	12	16
10th	35	37	72	2	10	12
11th	× 46	54	100	5	13	18
12th	× 42	70	× 112	× 7	11	18
13th	× 60	× 87	× 147	× 6	5	11
Means	36	70	106	5	32	38

* The mark × is placed against numbers in *excess* of the mean number.

† It is to be observed that in Middlesbrough during five out of the first six four-weekly periods of 1888 the infant pneumonia mortality was above the average of the eight previous years (partly of course on account of the increased population), but as respects ages above 5 years, the pneumonia mortality was very much greater than that average (and greater than increase of population could possibly account for) from the 1st to the 11th four-weekly periods

Tables R. and S. show:—

1. That for *all ages* during *recent years* there has been a general correspondence between London and Middlesbrough (using here this name as including the several Local Board districts included in the inquiry) as respects the season of the year at which "pneumonia" has been most and least prevalent, the only material difference being that there has been in Middlesbrough a tendency to the decline of the greater current prevalence being delayed. That for *ages under five years* there has been, on the whole, a similar correspondence; but on the part of Middlesbrough a tendency for increased pneumonia prevalence to commence earlier, and for the decline to be less steady and regular. It is specially to be observed that while London shows a steady fall from the fourth to ninth four-weekly period, this fall has been arrested in Middlesbrough, and that during the sixth and seventh period there has been a tendency to increase even up to the average prevalence of the year. That *for ages above five years*, Middlesbrough and London have corresponded pretty fairly, the tendency in Middlesbrough having, however, been for the pneumonia to begin to increase a little later than in London and its higher prevalence to continue a little later also.

2. Comparing the annual rise, progress, and decline of pneumonia at ages under five and over five years in London and Middlesbrough respectively, we find that there has been some difference between the two places; for that, while in London there has been a general correspondence between the two age-groups in these respects (except that the prevalence among those over five years began to increase rather later than among those under five years, and to also decline a little later), this tendency has been exaggerated greatly at Middlesbrough, and that a mortality of those over five years scarcely declining, but maintaining itself nearly at the highest point, has been maintained up to as late as the sixth four-weekly period, notwithstanding that the mortality under five years was not above the average after the second four-weekly period. [Possibly the difference may be due to difference in climatic conditions; but if it were, one would, I think, scarcely expect the pneumonia above five years to have continued so high for four months, while that under five years declined as it did. Mere climatic conditions, one would think, would affect both age-groups and not one to the exclusion of the other. It looks very much as if some other and additional factor had been at work at Middlesbrough.]

3. But now as to the individual year 1888. What is first worthy of remark is the general seasonal correspondence of the prevalence above the mean in this epidemic year with similar prevalence above the mean in previous years. The season is the same in both instances, both for all ages and for ages under five and for ages over five years. The epidemic occurred in the pneumonia season both of London and of Middlesbrough, speaking generally. And as respects the difference in Middlesbrough between the seasonal prevalence under and over five years of age, it was much the same in 1888 as it had been in previous years; the pneumonia over five years continued to increase and to remain above the mean of the year long after that under five years had declined and had remained below the mean of the year: and moreover, whereas in the total of previous years there was a remarkable

augmentation of pneumonia in the sixth four-weekly period, a similar augmentation not only to the mean, but above the mean. was observed in the sixth four-weekly period of 1888, preceded by an augmentation up to the mean in the fifth four-weekly period. The sixth period in 1888 was, it is to be observed, the period in which the epidemic attained its maximum for all over five years of age. Notwithstanding this, the correspondence with previous years just mentioned looks very much as if there was some additional epidemic cause operating in 1888 even upon infants as well as upon adults (but much less obviously) which was not operating in previous years in the fifth and sixth four-weekly periods.

4. I have only further to remark, as to the sudden drop, in the epidemic prevalence in Middlesbrough in 1888, after the sixth four-weekly period, that it had its counterpart in previous years in the same district, and in London also, in the totals of mortality for nine years.

For ages above 15 years, reference may be made to Chart I. for the correspondence in season between the ordinary prevalence of pneumonia in previous years in Middlesbrough and its epidemic prevalence in 1888.

2. *Relation of the Epidemic to Weather.*

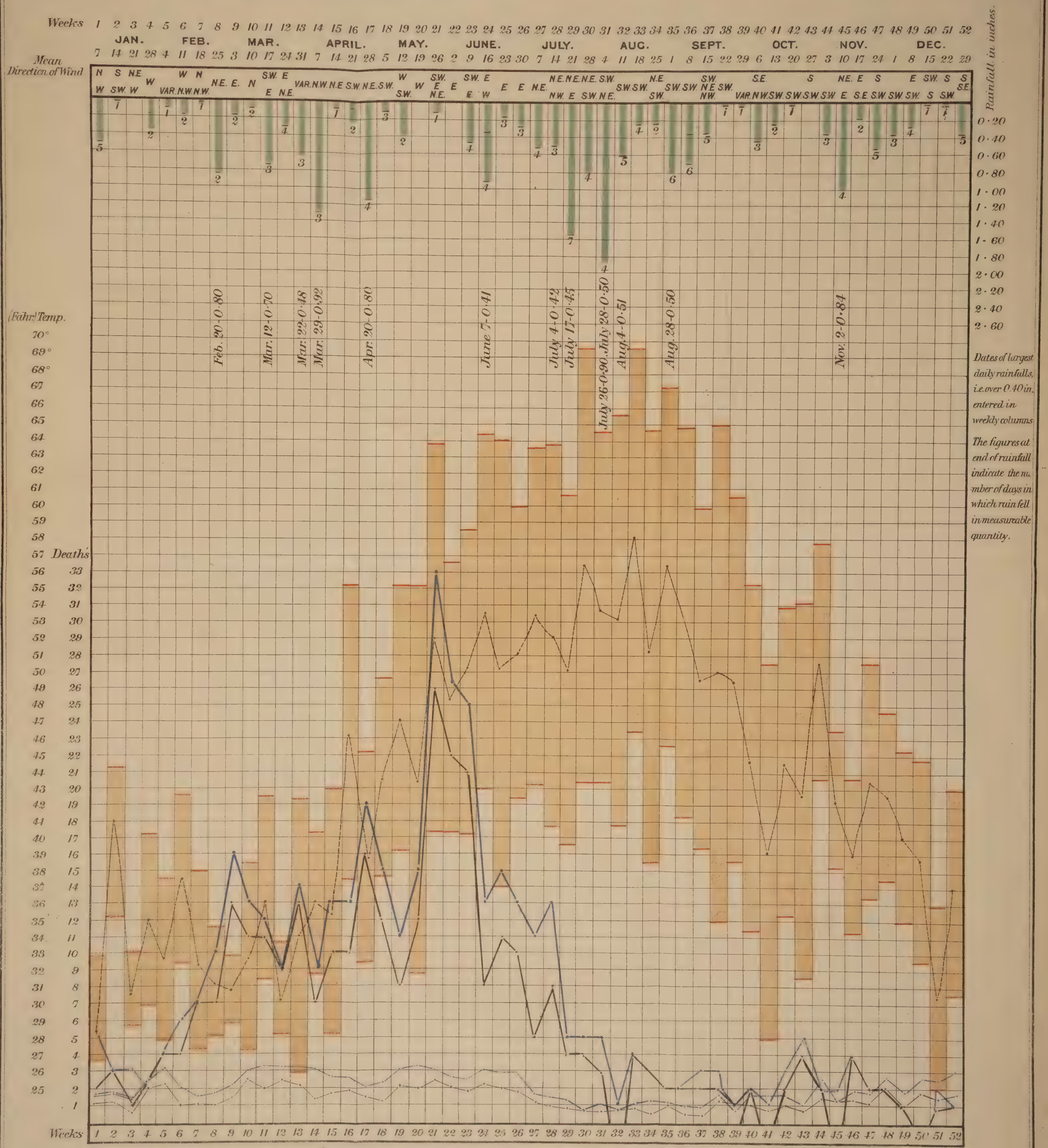
I propose discussing this point with the aid of a record of some of the elements which constitute weather, which record was kept at Albert Park. In Table III. (p. 264) are stated in figures, and on Chart II. graphically, the mean temperature and mean range of temperature of the air during each of the 13 four-weekly periods of 1888, together with the deaths from pneumonia over 15 years of age (and in the case of Table III. at all ages also), which occurred in the districts included in the inquiry in each of the same periods. Chart I.* extends this information to each of the 52 weeks of the year. Thus weather and the progress of the epidemic week by week and four weeks by four weeks, may be compared the one with the other. This table, studied together with the charts, appears to indicate as follows:—

1. That although the wind blew from the north-east, east, and north-west during the first three months of the epidemic period, this *special* prevalence of wind from those quarters ceased to be observed subsequently or during the period that the epidemic was at its height. There was more north-easterly wind during the time that the epidemic was declining in the seventh and eighth four-weekly periods, than there had been during the weeks when it was at its height. During these seventh and eighth periods I

* These charts require some additional explanation. The mortality lines in Chart 1 represent the deaths which actually occurred in the course of the seven days of each calendar week ended at the dates given. But the meteorology represented is not that of those precise seven days, but is the mean of the seven days ended four days prior to those dates. Thus the meteorology entered for the week ended January 7th is the meteorology of the seven days ended January 3, and so on through the chart. Some moderate adjustment of this sort appeared necessary when the progress of the epidemic was being represented by deaths occurring and not by cases commencing in each week, the object of the chart being to show the influence of weather on the progress and prevalence of the disease in weekly periods and not the mere relation of weather to mortality. Allowance had to be made for some days duration of sickness before death. A similar explanation applies to Chart II. and Table III.

CHART I.

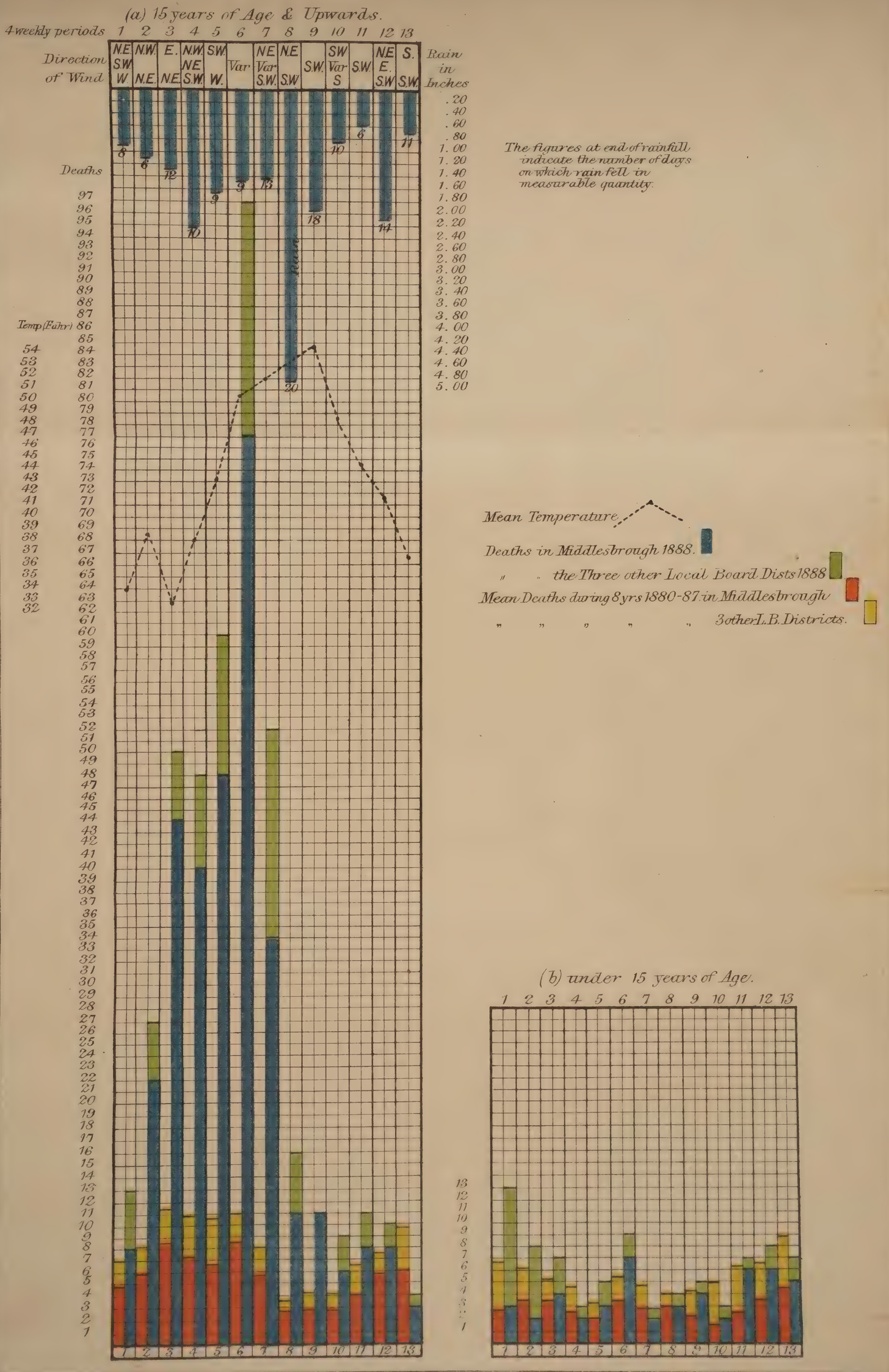
Showing week by week for persons aged 15 years and upwards, the progress of the Epidemic and the relation of the Mortality at these ages from "Pneumonia" in Middlesborough and the whole District, (including the three Local Board Districts) to certain Meteorological Conditions, showing also the mean weekly Mortality during the previous 8 years.



Dangerfield Lith 22, Bedford St Covent Garden 18498(5.89)

CHART II.

Chart showing in 13 periods of 4 weeks each for persons under and over 15 years of age separately the progress of the Epidemic and the relation of the Mortality from Pneumonia in Middlesbrough and the whole district (including the Three Local Board districts) to certain Meteorological conditions and also the mean annual Mortality during the previous 8 years.



DANGERFIELD LITH. 22 BEDFORD ST COVENT GARDEN. 18497 (789)

was myself at Middlesbrough, and had ample experience of the misery, and chill to the skin, that resulted from the damp and fogs combined with the north-easterly winds that prevailed at that time,—at a time, I repeat, when the epidemic was not increasing but markedly on the decline. These meteorological conditions were obviously then not the cause of the epidemic of "pneumonia." It would be another thing to assert that exposure to such weather did in individual cases assist something else in causing an attack of the disease. In such a statement I would readily concur.

2. Mere cold weather could not have been the cause of the epidemic, for it is evident from the Table III. and Chart II. that the epidemic commencing before the atmospheric temperature attained its minimum, though at a time when it had risen above that of the previous month, steadily increased to its maximum during a three months steady rise of temperature, and then fell from its maximum rapidly while the atmospheric temperature continued to rise; indeed the serious epidemic prevalence was all over a long time before the atmospheric temperature reached its highest point for the year. Nevertheless I shall, I believe, be able to show that exposure to cold had in individual cases an influence in assisting the operation of the causa vera (p. 239).
3. The sudden and frequent vicissitudes of temperature to which the Middlesbrough district is habitually subject may have had more to do with the epidemicity of the pneumonia than the conditions of weather just referred to. Vicissitudes of temperature was a condition of weather I had personally to encounter even during July and August last year. But this is an habitual condition in the early part of the year, and, except perhaps in its unusual prolongation into the months of July and August, was not peculiar to 1888. And it is not mere vicissitudes of temperature which are calculated to render Middlesbrough more liable than some other parts of the country to acute pulmonary disease, but the atmospheric dampness which is apt to be associated with the sudden changes from warm to cold, changes which may occur in the course of an hour or two, and which are not recorded at Albert Park. But Stockton, only three miles higher up the Tees, suffers similarly, and so does Redcar, which is only a few miles to the east of Eston; yet the epidemic of 1888 did not extend to these places. Nevertheless, it is not improbable, from what we know of pneumonia, that such vicissitudes of temperature contributed in the production of the epidemic. Still it is to be observed that during July and August, notwithstanding the continuance of these vicissitudes, and notwithstanding the increasing difference between the day and night temperatures, the pneumonia epidemic was fading away. This is shown in Table III., where the column relating to range of temperature obviously does not help explain the occurrence of pneumonia in an epidemic form.
4. The only remarkable point that comes out on studying the Table III. and the charts, especially Chart I., is a relation between amounts of the pneumonia on the one hand and varying conditions of rainfall on the other. This relation is a striking one. It cannot fail to be in recollection that the year 1887 was one of remarkable drought throughout the country, producing in some parts almost a water famine, and at least great scarcity in respect of the water supply of some of our large towns. In every month until November the rainfall was more or less below the

average, and it was especially below the average in the first, second, and third quarters. In the month of November, however, a large amount of rain fell, and Middlesbrough appears to have shared in this downfall. But in December the rainfall again fell below the average, and 1888 opened with a deficiency of rain. During the first four weeks of the year in Middlesbrough there were only eight days on which rain fell at all, and in the second four weeks there were only six days in which rain fell, and only one day, namely, February 20th, that it fell in any quantity (0·80 in.). It was during this second four-weekly period that the epidemic commenced. The rainfall in the first four weeks had been less than 1 inch, and that only in small quantities at a time. The fall of rain on February 20 seems to have had some good effect, for although it was followed by almost complete absence of rain during the next two weeks, the epidemic mortality, which had risen to 16 deaths, ceased to rise further. Then came four rainy weeks, during which a considerable quantity of rain fell at intervals, and it was not until another fortnight's drought occurred that the pneumonia mortality again rose. The pneumonia seemingly received another check from a rainfall in the 17th week of the year, which again appears to have been operative in driving down the mortality for two weeks, during which little rain fell. Then followed three weeks of almost absolute drought, and it was at this period that the epidemic mortality was at its highest. An examination of the weekly chart cannot fail to impress an observer with this coincidence; on the cessation of this drought the pneumonia mortality fell to about the level of what it was before the five or six dry weeks set in, but the epidemic did not come to an end until after an abundance of rain had fallen during the 29th, 30th, and 31st weeks of the year. In this connexion I wish here to call attention to the fact that throughout all these vicissitudes of rainfall and drought the influence of one or the other upon the mortality was on the whole not immediate. It could not be expected to be so, seeing that a period of some days elapsed between commencing sickness and death, and that some allowance has also to be made for a period of incubation of the malady.

It appears to be clear that the rain deficiency during the first part of 1888 had some causative connexion with the epidemic prevalence of the disease. That it was not the principal cause of it, however, appears from two circumstances; namely, that the epidemic did not re-appear on recurrence of drought towards the latter end of September and in the month of October, and that there was no similar epidemic in 1887, when the drought was so severe and long continued. The drought assisted in some way (that will be discussed later on in the report, pp. 235 and 258), but was not the principal cause of the epidemic.

3. *Relation of the Epidemic to certain Physical and Social Circumstances.*

a. Elevation.—Arranging the several parts of each sanitary district in the order of their elevation above Ordnance datum (which can only be done approximately but this, as will be seen, will suffice), the mortality above 15 years of age per 10,000 of the total population at particular levels in the district, during the epidemic period of 1888, was as follows:—

TABLE T.

Approximate Elevation.	Locality.	Urban Sanitary District.	Estimated Population.	Pneumonia Deaths at 15 years and upwards.	Deaths per 10,000 Population.
About 150 feet - -	Eston village and California -	E.	3,619	2	5·5
100 feet - - -	Normanby village - -	N.	1,391	—	—
About 35 to 40 feet -	Grange Town - - -	E.	4,900	15	30·6
Mostly 25 to 40 feet and upwards (some at western part 20 to 25 feet).	Northern district of Middlesbrough (north of railway).	M.	17,689	104	58·8
Mostly 25 to 35 feet (some under 45 feet, and some under 25 feet).	Part of Middlesbrough south of railway, viz.:—	M.	24,592	54*	22·2
	South-west District -	M.	26,974	92	34·1
	South-east „ -	N.	7,678	31	40·1
About 25 feet - -	South Bank - - -	E.	2,112	6	33·1
	Eston Junction and Branch End (virtually part of South Bank).				
	North Ormesby - -	O.	8,580	15	17·4

* Omitting Workhouse.

There is nothing like a regular gradation of mortality having relation to elevation observable here.

b. Crowding of Persons and of Dwellings upon Area.—The following table will assist at arriving at some inference upon this point:—

TABLE U.

Locality.	Urban Sanitary District.	Approximate Area in Acres of Populated Parts.	Estimated Population.	Persons to 1 Acre.	Deaths 15 years and upwards per 10,000 Population (all Ages) during Epidemic Period.
North Ormesby - - -	Ormesby - -	47	8,580	183	17·4
Middlesbrough, North District	Middlesbrough -	100	17,689	177	58·8
South Bank, Eston Junction, and Branch End.	Eston - -	60	9,790	163	37·8
Grange Town - - -	„ - -	30	4,900	163	30·6
Middlesbrough, S.W. District	Middlesbrough -	190	24,592	129	22·2
„ S.E. „ -	„ -	232	26,974	116	34·1

This table affords some indication that density of population may have had influence upon the spread of the epidemic. But such a point as this cannot often be determined statistically by comparing areas so large as these, except when, of the areas compared, the density of population of each area individually is fairly uniform in all parts of it. And this condition is not fulfilled in all the localities in the table. Such uniformity is most nearly attained, I believe, in the instances of the populated parts of Middlesbrough North and Middlesbrough South-west, and in Grange Town, and by limiting the comparison to these three localities, the indication of the influence of density of population would seem to become more obvious. Middlesbrough North abounds in narrow streets and courts, and all the common lodging-houses in the borough are situated in it. There are very few courts in Middlesbrough South-west, and these are situated in the older portion nearest to the railway, and there are no courts or common lodging-houses at all in Grange

Town. The indication thus obtained statistically is confirmed by my own observation (which of course could not stand as evidence by itself), that it was mainly in the more densely peopled part of every division of Middlesbrough, and of the other districts included in the inquiry, that the mortality was greatest; and, so far as my judgment goes, it was in these places greater than actual population would account for. It was also evident to me, as the result of my personal inquiries, that, apart from mortality, the disease, as a disease, spread more readily and was more common in the crowded portions than in portions less crowded. The inhabitants of close, ill-ventilated courts, of narrow streets, and of some lodging-houses suffered very severely. I may mention as examples of this the narrow streets and courts on the west side of Durham Street, and the neighbourhood of Union Cottages in Lower East Street, both in the north district of Middlesbrough. My belief also is that the fatality of the disease was also higher in these crowded places than it was elsewhere. Of the 21 common lodging-houses in this, the north district of Middlesbrough, 12 I know certainly had cases in them, from 1 to 8 in each. Altogether in these 12 houses I obtained information of 37 cases, of which 13 were fatal. There were probably others in other lodging-houses, but they did not chance to come to my knowledge with sufficient certainty to be counted in. It was the same in the south-eastern district of the town; the greater part of the deaths occurred in the more crowded parts between Corporation Road and Ormesby Road on the south, and Wilson Street and the railway on the north.

c. Rank or Station in Life, in its relation to the Epidemic.—The only means available for information as to this subject has been investigation of the death registers, and in these the occupations of males alone are sufficiently specified for present purposes. Further, I have had to confine my analysis of the social position and occupation of fatal cases to Middlesbrough for the reason that it contains a more mixed population than the other districts; and it has been necessary to limit inquiry to 24 weeks of epidemic pneumonia. As a result I have analysis of 210 deaths, of which the following is an abstract:—

	Deaths.
1. Professional persons, including 1 beneficed clergyman and 1 Baptist minister	4
2. A tradesman class, including 2 stevedores and 2 clerks	20
3. A seafaring class, including 1 master mariner and 1 pilot	7
4. An artizan class	19
5. 1 waiter and 1 cabdriver	2
6. Iron workers and workers in ship yards, &c.	40
7. Engine-drivers and others of the labouring class having specified duties	10
8. Labourers (necessarily mostly occupied in the staple industries of the town)	108
	210

The table of the rateable values of the dwelling-houses in Middlesbrough (p. 170) gives only 24 per cent. of all the dwelling-houses as rated at 10*l.* and upwards, and 76 per cent. of them as rated under 10*l.* Of the persons specified above, the classes 1 and 2, with the master mariner and pilot (26 persons in all) may be fairly assumed to have resided in houses above 10*l.* rateable value,—and they constitute 12·4 per cent. of the

210. The remainder, 184 persons, or 87·6 per cent. of the 210, may be fairly assumed to have resided in houses under 10*l.* rateable value. If these assumptions are trustworthy, it would follow that, while all classes suffered to some extent from the mortality, the artizan class and those who lived by manual labour suffered something like twice as much from the fatal malady as the classes who were comparatively well-to-do.

The fact may be here called to mind that the staple industry of the district is the manufacture of iron and steel and the working up of these products in various ways in shipbuilding, &c. The mass of the artizans and labourers then may be properly designated "iron-workers," a class of persons who, according to some recent observations of Dr. Niven, the Medical Officer of Health for Oldham, would appear to be specially liable to death from pneumonia.

Dr. Niven gives in his Annual Report for 1888 the estimated populations and deaths from pneumonia in Oldham as follows :—

Borough of Oldham.	Cotton Operatives.	Iron-workers.	Others.
Estimated population -	35,000	12,000	21,000
Deaths from pneumonia -	20	31	71

Besides the 31 iron-workers who died, there were 24 deaths among "labourers," many of whom were iron-labourers.

4. *The Pneumonia in relation with Food.*

I have stated already (p. 209) that when I commenced the inquiry at Middlesbrough I found three notions of its causation principally rife, viz., that the epidemic disease was due to the inhalation of slag dust, that it was due simply to seasonal causes, and that it was due to infection from person to person. Each of these supposed causes of necessity engaged my attention ; but while holding my mind open on the questions involved, I began at once to look about for some condition common to the population, and especially to the labouring part of the population, which might have been a medium for dissemination of a malady which (whatever designation it might at the time bear or might subsequently obtain), I early recognised as having the characteristics of a specific disease. I had found the pneumonia limited as an epidemic virtually to a certain area,—not, as far as I could then learn, extending beyond the borough of Middlesbrough and the adjoining three Local Board districts of Ormesby, Normanby, and Eston. I therefore inferred that the specific cause of the malady must have been something operating specially within that area. Casting about for such a cause, and meditating upon what I was able to learn speedily as to the habits and mode of life of the poorer and labouring population, and of the conditions affecting it, I began, as a result of a preliminary process of exclusion, to suspect the food of the people and especially the animal food they consumed, as possibly connected with the pneumonia ; and thus I set about inquiring in this direction. The then Mayor of Middlesbrough was the first person I applied to for information upon the habits of the people.

He told me that in the main the labouring men were given to intemperance in strong liquors, were rough, careless in their mode of life, and reckless in exposing themselves to chills by loafing about the street corners after quitting their work. It was obvious that these habits gave me no clue to a particular source of the pneumonia, and I proceeded to seek the information I needed from others, chiefly from the Inspector of Nuisances and from the medical men in the district; information which I afterwards myself supplemented by personal inquiries among the class referred to, especially in relation to their food. What I learned was this, namely, that wages being customarily paid on Saturday afternoon, part of them is expended in purchasing fresh meat, preferably lean beef, which is eaten at dinner on Sunday and serves for dinner, either cold or put into a pie,—at any rate for the men, who carry it to their work with them,—during the early days of the week also. The labouring classes commonly mark Sunday too by having some bacon or bacon and eggs at their breakfast, even if they do not have bacon on other days of the week. After that, on the latter days of the week, when the fresh meat of Saturday has been all consumed, bacon is mostly eaten or bacon with eggs, varied occasionally by some potted meat prepared in the town, or with sausage. In this way a very large amount of bacon is consumed in the town and the Local Board districts referred to. Taken altogether it will be correct to say that it is the staple article of animal food consumed by the labouring classes there. Having ascertained this much, an old experience of mine as to another sort of specific malady produced by the eating of American hams, prepared in the same way as the American bacon consumed in Middlesbrough, came to mind, namely, the outbreak of choleraic disease which in 1880 I had investigated at Welbeck in Nottinghamshire. It is true that this latter was a disease the local manifestations of which were principally abdominal; but it was at the same time a *general* disease due to a bacillus present in the hams. Here, at Middlesbrough, I had to do with a specific malady, a general disease, the principal manifestations of which were thoracic. But I did not see why this difference should hinder me from pushing the inquiry further, especially as more or less severe pneumonia was one of the conditions produced in animals by feeding or inoculation with the Welbeck poisoning material, as also in the body of a man who died at Nottingham in 1881 from the "Welbeck disease" produced by the eating of some pork purchased at a shop in that town. Consequently I entered on investigation in this direction in Middlesbrough, and forwarded to Dr. Klein for experiment at different times 22 samples of bacon from different sources, all but two of which sources were in the infected district.

Of the 20 samples from the infected district, 13 were found by Dr. Klein to be "poisonous" to guinea-pigs and mice; the poisonous character of other 2 was "doubtful;" and only 5 were found not to poison experimental animals. The remaining two samples (of the 22) were:—one, home-made bacon from an isolated house about a quarter of a mile from Stockton and about three miles from Middlesbrough, where cases of the disease had occurred some months before (see Burton's case, p. 228); the other, bacon from a large shop in South Stockton. The former proved "poisonous," the latter "not poisonous," to experimental animals. I was specially induced to push the inquiry further in this direction by the circumstance that of the samples of bacon earliest obtained no less than three (all of them reported by Dr. Klein as "poisonous") were from houses where I found persons sick with the disease, who shortly before their attack had partaken of the bacon thus, so to speak, captured.

The following are the sources in detail from which the 22 samples were obtained. It will be observed that *all* the samples of bacon obtained at houses where there was, or had previously been, one or more cases of the epidemic pneumonia, were found by Dr. Klein to be "poisonous" to rodents:—

Captured in Infected District.

Date of Capture.	Case.	Residence.	Result of Feeding of Animals by Dr. Klein. Samples of Bacon. Poisonous.	Doubtful.	Not Poisonous.	Where said to have been obtained.
June 27	Case XII., p. 305	Middlesbrough	1	-	-	P.'s wholesale shop, Stockton.
July 5	Do.	Do.	1	-	-	Do.
„	Case XVII., p. 307	Grange Town	1	-	-	Grange Town market.
„	Case XV., p. 306	South Bank	1	-	-	X.'s shop at South Bank.
July 12	Case XXV., p. 309	Middlesbrough	1	-	-	Salted down and dried at home (pig killed in Ayresome Lane).

Captured Three Miles from Infected District.

August 16	Burton's case, p. 228	Near Stockton	1			Home cured (pigs kept and fed at home).

Purchased Samples in the *Infected District.*

Date of Purchase.	Number of Samples.	Result of Feeding of Animals by Dr. Klein. Poisonous.	Doubtful.	Not Poisonous.	Where purchased, &c.
July 5	2	2	-	-	X.'s shop, Middlesbrough, N. district.
„	2	-	-	2	W.'s shop, Middlesbrough, N. district.
„	1	-	-	1	Y.'s shop, Middlesbrough, S.E. district.
July 7	1	1	-	-	X.'s shop in South Bank.
„	1	1	-	-	V.'s shop in South Bank.
„	1	1	-	-	Stores in Grange Town.
„	1	1	-	-	Stores in Eston village.
July 16	1	-	1	-	U.'s stall in Middlesbrough market, N. district.
„	1	-	-	1	T.'s stall in Middlesbrough market, N. district.
„	1	-	-	1	S.'s shop in Middlesbrough, N. district.
„	1	1	-	-	R.'s shop in Middlesbrough, S.E. district.
July 14	1	-	1	-	S.'s shop in Middlesbrough, S.W. district. [A small dealer who retails bacon purchased of X.]

Purchased in *South Stockton.*

July 5	1	-	-	1	

What is meant by the term "poisonous" as used above may be gathered from Dr. Klein's account of his experimental feedings in the Addendum B. to this report. Briefly, the result of these experiments of his was this, viz., that rodents (mice and guinea-pigs, mice chiefly having been used) in a large proportion of instances were made ill, and about 50 per cent. of the mice died in between 24 and 72 hours. Mice were apparently more susceptible to feeding with this poisonous material than were guinea-pigs. Examination of the bodies of the dead animals showed lung lesions, together with morbid changes in other viscera, identical with what had been produced in mice and guinea-pigs alike by inoculation of the juice of human pneumonia lung and by inoculation of the "bacillus pneumoniæ" obtained by culture from the diseased lungs and from the experimental animals. Further, this same bacillus was recoverable by cultivation from the tissues of the animals dead from feeding on the bacon, and the disease induced by the feeding was transmissible by inoculation to other healthy rodents of the same kind.

What inference is to be drawn from these facts? Do they, or do they not, show a connexion between the consumption of bacon in the infected district and the epidemic malady in the same area, in the sense that the former played a part in the production of the latter? There can be no question that all the bacon captured in infected houses and most of the bacon purchased in the infected district was found to be poisonous to rodents, and to contain (as shown by cultivation from animals poisoned with it) the same bacillus as existed in the lungs of men and women dead from the Middlesbrough pneumonia disease; but it does not necessarily follow, notwithstanding the large use of bacon as an article of food in the infected district, that the eating of the bacon produced the disease in man.* It may be that man is less susceptible

* Referring specially to the Cases XII., XVII., XV., and XXV. in the houses of which patients I captured bacon found to be infective, it has here to be pointed out that there was in all these instances the possibility that the bacon had derived the infective quality from the sick person in the house as well as the possibility that it might have been infected when purchased. The bacon in the instance of Case XII. was captured on the fifth day of illness: it had been purchased at Stockton from a large maker there, this town being free from epidemic pneumonia disease. In the instance of Case XVII. it was captured on the fourth day of illness. In the instance of Case XV. it was captured on the third day of illness: it had been obtained at a shop (X's) where bacon which I purchased was found to be infected. In the instance of Case XXV. it was captured on the fourth day of illness. In the instance of Burton's case, p. 228, the bacon was captured several months after illness had terminated in the house. Something more must be said, however, about these last two instances. As to Case XXV., the story I elicited by careful inquiry was this. A farm labourer, Roberts, residing in an isolated cottage not far from the Union Workhouse, the premises at the rear of whose cottage were filthy (when I visited them in August 1888), from bad drainage and other nuisances, fatted upon meal and potatoes towards the close of 1887 three pigs. One he killed in October and sold the carcase as "pig-meat." A second he killed the week before Christmas: he salted down the carcase at his house, kept one half for consumption in his own family, and sold the other half to J. A. of South Bank, who dried it at his own house. No case of "pneumonia" occurred in Roberts' family, but J. A. was taken ill with the epidemic pneumonia and died from it on June 17. The third pig was killed the week after; half of this carcase was sold as "pig-meat," and the other half was salted down by Roberts at the house of Case XXV. in Middlesbrough, and was dried by hanging it in the kitchen. The bacon here may have gathered its infective quality in consequence of exposure to infective emanations in Middlesbrough, and so have been a cause of the man's attack, or, as suggested above, may have become infected from the case otherwise originating in the house itself. But it is curious and suggestive that Roberts and his family, whose premises are not connected with the Middlesbrough system of sewers, should have escaped while cases happened in the two families which, in Middlesbrough and South Bank, consumed portions of the carcases cured and dried or dried only in these towns. Burton's case is referred to in detail at p. 228. There is something to be said, therefore, on both sides, and both possibilities must be kept in view.

of infection in this way than even guinea-pigs are, or indeed that he is not capable of being poisoned in this way at all. We may indeed read the facts in another way, and infer that the bacon which produced the pulmonary disease in experimental rodents had become infected, directly or indirectly, by the bacillus emanating from the sick persons in the houses where it was captured, or (in the instance of the samples purchased elsewhere) infected from the pneumonia cases scattered through the district; in a word, that man infected the bacon instead of bacon infecting man.

In endeavouring to answer the questions involved, it will be necessary to enter somewhat fully into details.

The bacon used in Middlesbrough throughout the infected district, almost universally, and indeed solely by the working classes, is of the kind commonly known as "American" bacon. It does not come from America, however, in the *form* of bacon, but as salted pork. It is imported packed with salt or borax in wooden cases, the carcases of the pig being divided in pieces of convenient size for this sort of packing. It is made into bacon in this country, and in some towns there are large factories where this process is carried on, the bacon so made being subsequently distributed more or less extensively over the country. For instance, a large factory situated at Stockton distributes American bacon largely in neighbouring counties and some in London. Hams made here are sold in London by some retailers as York hams, just as during my Trade Nuisance inquiry I found hams made in South Shields were sold elsewhere as "Cumberland hams." There are four places in the town of Middlesbrough where this sort of bacon is made, but none in the other three infected Local Board districts. But a peculiarity of the Middlesbrough bacon industry is this, that practically the whole of the bacon made there is sold in Middlesbrough and the infected districts, and practically none of it is sold outside the infected district. The mode of its preparation is this:— The salted pieces of pork are first soaked and washed in water in a tank or other receptacle of wood or of cemented brick or stone, to remove as much as possible of the salt about and within them. They are then taken out of the tank and placed on a rack or elsewhere to drain. When sufficiently drained, the process of drying is commenced. The usual mode of drying is to hang up the drained pieces in a chamber, the air of which is heated, but moderately, by means of braziers in which a coke fire is kept burning, for about 24 hours; the object being not actually to dry the pieces as Wiltshire bacon for instance is dried, but simply to dry off superfluous water. Then subsequently they are hung up for some days in a chamber not specially heated to dry further. I am informed by a large factor in Stockton that the object of all this is to produce an article such as the labouring classes prefer, namely, a kind of bacon which is mild (*i.e.*, not too salt), and in flavour as much like uncured pork as can possibly be obtained. The bacon thus made of course contains more water in its composition than ordinary dried English or Irish bacon, is more profitable thus for sale, and can be sold profitably retail at 4*d.* or 4½*d.* per lb. The rind of such bacon is pale in colour. A small proportion of the bacon thus made is smoked in the usual way that English bacon is smoked. It is then more dry, has a darker rind, and is saleable at a higher price: but this sort of bacon has no sale among the labouring classes in Middlesbrough. Of the four factories in Middlesbrough three are comparatively on a small scale; the largest is that of Mr. X., whose process differs from the ordinary process in a way that is perhaps worth mentioning. This gentleman has a wholesale as well as a retail trade, and supplies shops in Middles-

brough and in the infected district; he has a reputation for hams and bacon, and only purchases pork from the best American sources and of the very best brands. There can be no question about this. He has courteously and freely furnished me with every help and information in his power, and assisted me by suggestions as to this particular part of it. I am therefore under great obligations to him. On visiting his factory I found that instead of using coke fires to dry his pork, he has his chambers heated throughout with hot-water pipes. He told me that his motive in thus varying the drying process was that it appeared to him a more cleanly proceeding than the warming by open coke fires, and that he found that he thus obtained a better and more presentable article.

The suspected bacon thus used in Middlesbrough would scarcely be recognised as bacon by a London housekeeper of the upper middle class, who is accustomed to dried bacon of English or Irish growth and curing. It is moist, salted pork, rendered again by soaking as nearly like fresh pork as is practicable, and only so far dried afterwards as to remove from it the superfluous moisture introduced by the soaking process. We learn from Dr. Klein's observations (p. 325) that samples of this sort of bacon, which proved poisonous to rodents when administered to them within the period after manufacture at which it is customarily sold, were found to be no longer poisonous after they had been kept for two or three months. The bacilli, certainly in them when first used for experimental feeding, were, after this period of keeping, as certainly absent or else were dead and innocuous. During these two or three months, the warmest period of the year, the samples must have become considerably more dry. Possibly the bacillus pneumoniæ only infects pork when moist, and ceases to be noxious when infected pork has become fully dried by keeping or otherwise. But it is just in the moist and thus perhaps infective condition that the bacon is chiefly eaten by the labouring classes in Middlesbrough. This class of persons only live as it were from hand to mouth, and as a rule do not keep the "bacon" they purchase for more than a week, or a fortnight perhaps at the utmost; and the sale in the shops is a rapid one. This much being premised—

In support of a thesis that after all samples of bacon poisonous to rodents did not really poison human beings, as at the first blush of the thing they appear to have done, but that the human beings got their pneumonia disease in some other way, it may be contended that the rodents were fed with the bacon in the raw state while the human beings ate their bacon in a cooked state,—that is, after exposure to a heat sufficient to kill any micro-organisms it might have contained. And in this connexion Dr. Klein's observation might be quoted to the effect that his bacillus pneumoniæ is killed by exposure for five minutes to a temperature of 75° C. (165° Fahr.). No doubt due and proper cooking, whether by boiling or frying, would kill the bacilli and render infected bacon, if previously noxious to man, innocuous; but thorough cooking is just what the bacon eaten by the labouring classes at Middlesbrough does not get. As the operatives purchase this kind of bacon because it it most like fresh pork, so, as a rule, they cook it only slightly in order to preserve its juiciness. I have talked to them about this, and watched their proceedings, and can affirm that such is the case: a slice of bacon is commonly merely toasted upon a fork in front of the fire, and then only so far as to brown the outside of the slice moderately; certainly it is not habitually so fully cooked as to ensure all parts of the slice being raised for five minutes to the temperature of 165° F. or indeed anything like it. One reason there-

fore why the class of persons above the labouring class (see p. 216) suffered from the epidemic less than the latter, although eating probably equally infected bacon, may have been that, as a rule, their cooking of it was habitually more complete. With the former class the bacon would be probably used more as an appetising relish than as an article of diet from which it is sought to obtain as much nutriment as it can be made to furnish.

Further, in the same direction, it may (looking at what I have said just now) be contended that, had the eating of the American bacon been a cause of the pneumonia epidemic, that epidemic should have been much more extensive even than it actually was, seeing the very large use of it as an article of diet in the infected district (p. 218). A reply to this contention is that it is by no means a necessity that every piece of bacon manufactured in the same establishment, every lump of bacon or even every slice of bacon taken from the same lump, should be equally affected. Bacon infected with a living organism need not be infected in all parts alike, as it would be if permeated throughout by a chemical poison. The infection may be limited to a particular part of it, indeed possibly to a very small part of a piece; and, while the eating of this particular infected bit may produce disease, other parts may be eaten with impunity. Among the mice fed by Dr. Klein from the same piece of bacon, although mice are obviously readily infected in this way, some were rendered ill and a proportion of such died, while others remained unaffected; and so too with the guinea-pigs. Yet all the mice in whom the introduction of the bacillus was ensured by inoculation were made ill. It is the same with water or with milk infected with the *materies morbi* of enteric fever. Everybody who drinks the poisonous water or the poisonous milk is not made ill by it, and for the reason, partly, that the infecting material in the water or in the milk is (like the "bacillus pneumoniæ") particulate, and may be unequally diffused through a bulk of either. Moreover, as respects specific diseases generally, the same man is not at all times or under all conditions of the system equally susceptible to infection. I shall have occasion to show that this is so in respect of the Middlesbrough epidemic (see p. 240). He may resist it at one time, but be unable to resist it at another.

Direct evidence that the eating by man of bacon infected with the bacillus pneumoniæ produced the disease in man there is—and from the very nature of the case there can be—none. But even if direct evidence to that effect were forthcoming, it would be idle to contend that eating of bacon was the *only* way in which, in the epidemic area, the specific micro-organism, the *vera causa* of the disease, gained entrance to the human body. It is not, for instance, as if the question was as to a particular milk-supply being the cause of a series of cases of enteric or scarlet fever. All that anyone could contend for in the present instance would be that bacon might with very fair probability have been *one* of the means by which the material cause of the pneumonia got entry to the bodies of Middlesbrough people. And upon this view the following considerations become of importace, namely:—First, that it is more probable than improbable that when, of two omnivorous animals, both capable of digesting animal food and capable of being made ill in the same way by the *vera causa* of a given disease (when by some other channel introduced into the system), one is proved capable of being infected by the use of food containing this *vera causa*, the other is to be regarded as capable of being similarly infected also. It may be added that such an *a priori* probability was confirmed by experiment

in the instance of another kind of bacillus found in the Welbeck hams (American hams). Secondly, there is the fact that out of 12 cases that I visited and in which I inquired into the recent consumption of bacon I received an affirmative answer in 10. I know this does not go for much as evidence, but still it appears right to state it. It was not until I learned from Dr. Klein that the bacon and ham was poisonous to animals that I began to make this sort of inquiry. In these 10 cases bacon or ham had been last eaten from 6 to 36 hours before the attack. In some instances it had been eaten twice or even three times recently. If the bacon was the cause of the attack, the incubation period may be apparently fixed at from 18 to 36 hours, or perhaps a little longer. Thirdly, I must refer to the practice of the labouring classes of using bacon most freely towards the latter part of the week, and on Sundays for breakfast. If, then, the bacon eating had anything to do with the production of the disease, it would (allowing for incubation) probably be on Saturdays, Sundays, and Mondays, at any rate on Saturdays and the early days of each week, that the largest numbers of fresh cases would be expected to be found entered in the lists of the medical men who furnished mewith the most complete records of their cases; and that the smallest numbers would be on the other days. An analysis of 473 cases over 15 years of age, in which the date of attack is satisfactorily given in these lists, furnishes the following result:—

Attacked on	Sunday	68	mean 78
,,	Monday	89	
,,	Tuesday	67	
,,	Wednesday	69	
,,	Thursday	54	
,,	Friday	46	
,,	Saturday	80	
		473	

When I was in Middlesbrough the medical men told me that Monday was the day of the week when they always expected to have the greatest number of fresh cases, and they appear disposed to attribute this to the Saturday night's orgies at the public-house. But this explanation would not apply to the large number of Saturday cases shown by the lists.

All these considerations appear to me consistent with ability of bacon infected by the "bacillus pneumoniæ" of Klein to produce in the human individuals who ate it a similar disease to that which it certainly produced in rodents fed with it; and consistent therefore with consumption of the particular bacon in Middlesbrough and the adjoining invaded districts having been *one* of the factors in the epidemic outbreak. If this be so (and the estimation of the degree of probability lies with my readers), then the fact that it was only in that part of this corner of the North Riding of Yorkshire in which bacon manufactured in Middlesbrough was sold,* that the epidemic prevailed, becomes the more significant. The Middlesbrough bacon district and the epidemic-pneumonia district were, be it observed, coterminous.†

* Neither at Stockton, some three miles west of Middlesbrough, nor at Redcar, which adjoins Eston on the east, was bacon of Middlesbrough manufacture on sale.

† It may be stated, for what it is worth, that I have ascertained that there were 50 Jewish families resident in the town of Middlesbrough, numbering altogether 275 persons. Of these only one, a woman of advanced age, suffered from pneumonia.

5. *Communicability of the Pneumonia from the Sick to the Healthy.*

That the form of disease which I had to investigate at Middlesbrough was communicable from the sick to the healthy, would appear to be indicated in several ways.

But first, I may note that, *a priori*, it is in a very high degree probable that it should be so. I have shown that this pneumonia distinctly belongs to the class "general diseases," and not to the class "local diseases," in which class "pneumonia," both "croupous" and "catarrhal," was tabulated as recently as the year 1885 by the Royal College of Physicians of London.* Further it belongs to Group A. of these general diseases, that is to say, it is a "Specific Febrile disease" dependent upon a particular "morbid poison," a "contagium vivum," which has been isolated and which when experimentally inoculated into rodents induces in them similar disease. Now, communicability from the sick to the healthy through one or another medium is a quality attached to the large majority of the members of this group of diseases; not to each invariably, nor perhaps always necessarily, but still with sufficient constancy to warrant the assertion I am making. It is important, therefore, to ascertain whether the epidemic disease in Middlesbrough was in one or another way actually communicated from the sick to the healthy;—whether in regard of it there is forthcoming a sufficient array of clinical facts of the kind and amount which has sufficed to prove a similar proposition in respect of other general diseases of the A. group.

[At this stage, however, it is proper that I should guard myself by saying (what every member of the profession knows very well, but which every person outside its ranks may not know) that the members of Group A., which are thus communicable, do not all habitually spread from the sick to the healthy through the same media, or with the same readiness through different media. For example, small-pox spreads through the medium of the atmosphere directly from person to person, but has not been proved to spread through the medium of water. Typhus fever also spreads through the medium of the atmosphere directly from person to person, but has not been shown to spread through the medium of water or food. Enteric fever spreads from person to person notoriously through the media of water or food contaminated by the excreta of the sick, or by exhalations from them, and by the exhalations from sewers or drains similarly contaminated, though not directly through the atmosphere. Cholera and diarrhœa may spread in a similar manner to enteric fever, that is by the contamination of air and water or food by excreta or their exhalations, directly or indirectly; but not as a rule through the air directly from person to person. And so on.]

There will be convenience in referring to some of the characteristic features which pertain to communicable diseases before stating what I have ascertained as to these several phenomena in the instance of the disease under consideration.

1°. *Epidemicity*, frequent or only occasional, is one of the phenomena which characterise most of the communicable diseases. But as all diseases which occur epidemically from time to time are not accepted as communicable from the sick to the healthy, and as all diseases which are well known to be communicable from the sick to the healthy do not appear from time to time epidemically, little stress can be laid upon this feature of the Middlesbrough

* "Nomenclature of Diseases. Second Edition, being the First Revision. 1885."

disease. But the fact of its epidemicity in 1888 has a certain value, nevertheless, in this connexion.

2°. *The Occurrence of Multiple Cases in one House* or Family.—Such an event indeed is no evidence of communication of a given disease from the sick to the healthy, when standing alone as an exceptional occurrence; though it may have some significance in this direction when of frequent occurrence in the course of an epidemic. The reason for hesitating to accept infection from person to person in either of the above cases is that it might be that all persons attacked had been exposed to the influence of one and the same extraneous cause, living as they would have been under the same or similar conditions and surroundings. There is of course direct suggestion of infection from person to person when all the members of a household attacked are attacked not simultaneously or nearly so, but more or less consecutively.

3°. *Communicable diseases* spread most readily *under circumstances*, whether of locality or habits of life, which *conduce to the closest association of the sick with the healthy*.—One of these circumstances is aggregation upon a limited area as indicated statistically by the number of persons living upon a defined space of ground; another is crowding together of persons within dwellings.

Altogether there are (besides conveyance in food) at least four recognised modes in which communicable diseases may be transferred from the sick to the healthy, viz., (*a.*) directly through personal close intercourse in the sick chamber or elsewhere; (*b.*) by the attachment of infective material, proceeding from the sick, to the walls, floors, &c. of the room or house he occupies, to their furniture or contents and to the appurtenances of the premises generally; and (*c.*) through the agency of receptacles for filth (dustbins, ashpits, privies, &c.), or of drains and sewers into which discharges or excreta of the sick may have been thrown, or (*d.*) through the agency of drinking water contaminated with the infectious material.

I propose now to pursue this branch of the inquiry by passing under review any evidence there may be of the communication of the disease in Middlesbrough by each of these methods.

(*a.*) *Direct personal infection*.—The following are facts and considerations which appear to me to show that this pneumonia disease was *communicable from the sick to the healthy directly by close association the one with the other*, in the same way as typhus, scarlet fever, measles, whooping-cough, and other similarly infectious diseases are communicable. The evidence I have to adduce is on all fours with the sort of evidence which is regarded as convincing in respect to these other maladies.

1°. There is the fact that in a household in which multiple cases occurred it was observed that the persons most commonly and earliest attacked in sequence to the first case were those members who, from their position in the family, *e.g.*, husband and wife, brothers and sisters, mother and son or daughter, were naturally brought into closest personal relationship with the member or members sick of the malady. Several of the instances in Table XV., p. 292, illustrate this. In estimating the value of these several illustrations, as they bear upon the question of personal direct infection, the duration of the period of the illness during which infective material may be discharged from the lungs of the sick has to be taken into account: and as to this period I have no precise information. Taking from the first to about the seventh or ninth day of illness as including the period of febrile disturbance, after

which convalescence sets in and the lung commences to clear up, there remain several days before the lung returns to anything like its normal condition, and it may be well believed that, until this condition is attained, infective material is still being discharged from the lung in the sputa or in the expired air; and in addition there is an incubative period antecedent to definite illness to be allowed for.

Keeping all these considerations in view, I cite from Table XV. (p. 292) certain facts as to multiple cases in particular houses, as follows:—

Brothers and Sisters.

No. 1. Lizzie, attacked on 13th day of Alice's illness.
No. 8. Martin's brother, attacked on 17th day of Martin's illness. Patrick, attacked on 12th day of second case.
No. 16. Ellen, attacked on about 14th day of Michael's illness.
No. 24. Peter, attacked about third day of Bernard's illness.
No. 25. Frederick, attacked on the eighth day of Thomas's illness.

It is to be kept in mind that in the small dwellings of the poor having limited accommodation for a family, brothers and sisters (children) are commonly put to sleep together in one room, or even in one bed. In only three of the above five instances was anyone in the house beside those named attacked, viz., in No. 8 another brother some months later; in No. 16 a lodger at an advanced period of the illness of the children; and in No. 25, a mother who nursed her son.

Husbands and Wives.

No. 10. Wife attacked shortly before the death of her husband.
No. 13. Wife attacked on ninth day from commencement of husband's illness (incubation must have been *at least* two days). No other case at home.
No. 17. Wife attacked on sixth day of husband's illness (incubation *at least* one day).
No. 18. Wife attacked on eighth day of husband's illness.
No. 20. Wife attacked on 16th day of husband's illness.

In the above instances the wives had nursed their husbands. In two of the five instances only was anyone but the wife attacked in the house, viz., in No. 10, where a daughter was attacked about the same time as her mother, and in No. 20, where a lodger who had assisted in nursing the husband was attacked before the wife.

Father or Mother and Son, Daughter or Niece.

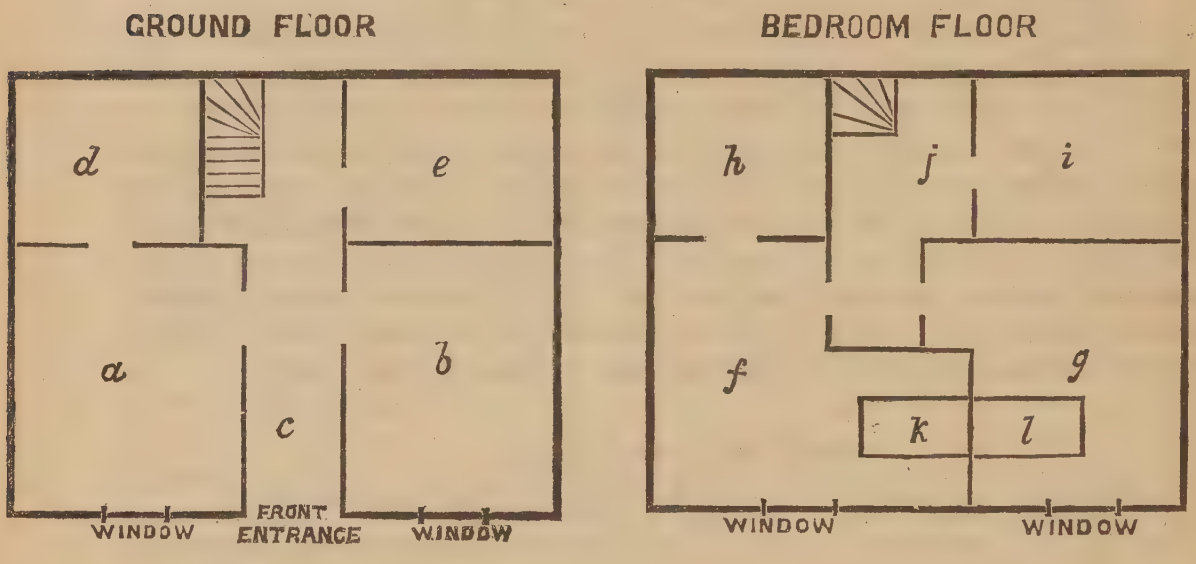
No. 9. Niece attacked on third day of aunt's illness (incubation not exceeding two days).
No. 10. Daughter attacked about fifth day of father's illness; mother also attacked (incubation not exceeding four days).
No. 15. Father attacked on 17th day of son's illness; slept in same room.
(?) No. 21. Son attacked six days after father's death. If this be properly placed in this category it would indicate that the incubation may last six days, but this seems not to correspond with indications of other cases.
No. 29. Mother attacked on fourth day of son's illness, whom she nursed.
No. 25. Mother attacked on seventh day of son's illness, whom she nursed.

App. A. No. 18.

On Pleuro-pneumonic Fever in Middlesbrough and neighbourhood; by Dr. Ballard.

The case of the Burton family (No. 25), at Mandale Mill, near Stockton, serves best to illustrate the quality of infectiveness that I am ascribing to the pneumonia, and accordingly I give the history of the attacks in this family in some detail.

Mandale Mill is situated on a main road about a quarter of a mile from Stockton (where there was no epidemic), and about three miles from Middlesbrough. The house and adjoining mill-premises are completely isolated, and have no connexion with the Stockton or Middlesbrough systems of sewers. The dwelling-house consists of two floors, the upper floor rooms being used as sleeping rooms, and the lower rooms for day occupation, &c. The following rough plan of the arrangement of the rooms is sufficient to enable me to explain the distribution of the family when the first case of illness occurred.



a. Kitchen and general living room.
b. Best parlour.
c. Entrance hall.
d. Pantry and storeroom for food.
e. Back kitchen and scullery.

f, *g*, *h*, and *i*. Bedrooms.
j. Landing on first floor.
k. Bed occupied by Thomas.
l. Bed occupied by Mrs. B., and subsequently by Frederick.

The family consisted of the father and mother, a son Thomas, aged 27, Frederick 19, Arthur 17, Joseph 9, Herbert 7, Eliza 23, Ann 14, and, Ada 12.

Thomas was the first in the house taken ill. Up to the week ended May 12 he had been an assistant master at a Board School in Middlesbrough, whither he went daily, returning home each evening. He never purchased dinner in Middlesbrough, but was accustomed to take his dinner from home with him, and to eat it in the schoolroom during the interval between morning and afternoon school. On Saturday, May 12, not being that day engaged in teaching, he went to Middlesbrough between 9 and 10 a.m. to attend a meeting of teachers, after which he went to the "Liberal Club," where he played at billiards and had some currant cake, a cup of tea, and a "pork-pie," which tasted, he said, very salt. Later he attended the funeral of the Rev. Mr. Rowlands (Case XIV., p. 306) as far as the church porch, and afterwards walked home from Linthorpe across the fields. He did not go to Middlesbrough on Sunday, but on Monday, May 14, went there to enrol scholars in a new school to which he had been appointed master. He was there from 9 till 12 and again from 1.30 till 4 o'clock. The room was ill-ventilated, crowded with mothers and children, who pressed about him, and as the windows were closed the atmosphere became very oppressive. Between the morning and afternoon attendances he threw the windows

open and ate his dinner,—cold mutton, cold potatoes, and cold cabbage,—that he had brought with him as usual from home. He says he had been suffering for about a week previously from a "cold," but had been otherwise in good health. After 4 o'clock he went home, had tea, and then went out for a walk, but did not visit anyone. When he came home he sat down to write, feeling in his usual health, but an hour and a half later he felt chilly, and went to bed, where he quickly suffered from distinct rigor. He soon became so ill that Mr. Hind, surgeon, of Stockton, was sent for. His condition then was such as to require the addition of ammonia to the saline medicine prescribed. He passed through a sharp attack of the pneumonia, but ultimately recovered.

When he was taken ill his mother nursed him, and at Mr. Hind's suggestion the sleeping places of the several members of the family were re-arranged. Thomas occupied his own room, *f*. The father slept in *g*, Frederick (who slept in the same room with Thomas up to the second night of his illness), Joseph, and Herbert in *i*, Arthur on a sofa in the kitchen, and Ann and Ada, who had previously slept in *h*, which communicated by a door with *f*, were put to sleep in a bed on the landing, *j*. Eliza slept from home, but for one night assisted to nurse her brother Thomas.

The only members of the family subsequently attacked were the mother and the brother Frederick. Thomas was the only one of the family that had recently been in Middlesbrough. Mrs. Burton, aged 50, was taken ill on Sunday, May 20, at 5 a.m. (this being the seventh day of Thomas's illness). She had had six days close attendance on him in nursing. Her illness commenced as usual with rigors, pain in the right side and round the hips, and these symptoms were followed by the distinct signs of pneumonia as recognised by Mr. Hind. She was put into *g*, and her husband went to sleep in *i*: a nurse was now engaged, and, when she was resting in bed, the father took a spell at nursing, sometimes even at night. Mrs. B. had not so severe an attack as Thomas, and ultimately recovered.

Frederick was the third attacked. He was an apprentice to a bridge-maker. He had suffered for about a week with a "cold." He also had a share in the nursing of his brother and mother. He was taken ill two days after the mother, viz., on Tuesday, May 22, and had, as stated by Mr. Hind, the most severe attack of the three, but he also ultimately recovered.

Mr. Hind states that the pneumonia in these cases was of a type he was not accustomed to see in Stockton, even while the disease was epidemic in Middlesbrough; there was decidedly more prostration, for which he had throughout to administer ammonia in the medicine prescribed.

It is to be observed in this instance that the two out of the four persons (the mother, Eliza, the father, and Frederick) who took part in the nursing were attacked, viz., the two who did most of it,—the mother first and Frederick two days later.

[It may here be added that no purchased bacon was used in this family. Bacon was habitually eaten at breakfast, but it had been fed and cured on the premises. Whether or not the "pork-pie" eaten by Thomas on May 12 in Middlesbrough had been made with salted (American) pork or bacon, could not be ascertained; but in any case, it appears evident that Thomas became infected in Middlesbrough, where the disease was then epidemic, and that subsequently the disease spread in his family, especially among members most closely in relation with him during his illness.]

The 29 houses on Table XV. with which I have been dealing by no means exhaust the total number in which multiple cases of pneumonia occurred; they are adduced as samples only of occurrences that were by no means uncommon in the Middlesbrough district during the epidemic. These 29, however, furnish 15 or 16 illustrations of time and other relations of cases among near relatives, of a sort strongly to suggest direct infection from person to person.

Among these 15 or 16 instances of possible communication of the pneumonia by direct infection of near relatives in the same house, there are four cases in which the relative attacked is distinctly stated to have been engaged in nursing the sick, viz., in Nos. 17, 20, 29, 25; and other three (Nos. 10, 13, and 18) in which it may be taken as certain, although not distinctly stated, that the persons suffering secondarily had nursed the antecedent cases. Of the four instances in which lodgers in the infected house (not being a common lodging-house) were attacked within a short interval of the other cases in the house, viz., Nos. 16, 20, 22, and 26, the lodger affected was, in two instances (Nos. 20 and 22), distinctly stated to have taken part in nursing the sick.

I may add here the case of Early (Case XXXIII., page 312), who was taken ill at the Union Workhouse on December 10, 1888. He was at that date the only inmate that had been attacked since November 11. From the date of his admission on November 13 he had been assistant to the nurse in the pneumonia ward, where several cases were under treatment.

Leaving now the sequence among close relatives living in the same house and among lodgers in private dwellings, reference may be made to the sequence of disease in lodging-houses. I have only two illustrations of this recorded in Table XV., viz., Nos. 7 and 15. Of these, No. 15 alone appears available here. The lodgers in this house were mostly permanent lodgers, some of whom had resided there for years, and the proprietress of the house habitually treated them with kindness and attention. They associated in the daytime (when at home) in a common room in the basement floor. There was, at the time of the illness there, "something wrong with the drainage in the yard." But the point to which I desire to draw attention here is,—that the *second* case in the house was in a man who slept in the same room with the earliest case (at first in the same bed with him), and was taken ill on the fifth or sixth day of his illness; that the third case slept on the same floor as these two persons and in the nearest of two rooms opening from the landing, and was taken ill about the same day as the second case; and that the seventh case slept in the same room as the third case, and was taken ill on the ninth day of the latter's illness, and five days after he had been removed to the hospital. (If this man got his infection directly from the third case the incubation must have been at least five days.)

2°. Leaving Table XV. and its indications, I cite a number of instances recorded upon the lists of cases furnished me by the medical men of Middlesborough and its neighbourhood, or otherwise coming to my knowledge, in which persons *not residing in the same house with the sick* were attacked shortly after visiting or nursing pneumonia cases.

1. Volunteer-Corporal J. Hicks, aged 30, a joiner, residing in Middlesbrough, was on Monday evening, May 28, sitting before the fire at the Shakespeare Hotel, when he was suddenly seized with rigors and vomiting. The hotel-keeper, seeing how ill he was, had him put to bed in the hotel, and he was attended by a medical man. Dr. Craster saw him the next day, when the signs of pneumonia were pronounced, and the sputa of a distinctive character. His temperature was then 103° F.,

and he was delirious. He became worse, and died on June 1, on the fifth day of his illness.

William Bowie, aged 30, a mechanic, residing at 6, Shakespeare Street, and also a volunteer, was with Hicks and nursed him on June 1, the day of his death. Hicks was a robust man. The next day, June 2, he attended drill at Redcar, and in the evening returned home wet through. That same evening he had rigors. Dr. Veitch saw him the next morning, when the signs of pneumonia were evident. On the third day of his illness he had epistaxis, and died "from syncope" on June 9, the eighth day of his illness. The incubation period in this case was therefore about 24 hours,—if it were a case of personal direct infection.

[In connexion with this case the following may be mentioned, although it has no bearing on the question of personal infection. A man, named John Farthing (or Farden), said by Dr. Craster to have been a hanger-on at the hotel, by the relieving officer to have "no "residence and to have slept in a cab," and, as subsequently ascertained, employed about the hotel in odd jobs, cleaning the cellar yards, &c., was taken ill with pneumonia, and on June 6 was received into the workhouse infirmary ill with the disease. He died from it on June 7. It appears that he was never upstairs in the hotel, and on no occasion, therefore, in the same room with Corporal Hicks. The precise day he was first seized is not known, but he could not have been ill long, as when he was told the nature of his disease he had strength enough to walk over a mile to the workhouse, during which walk he went into several public-houses for "refreshment." No one else connected with the hotel was taken ill.]

2. Thomas Maynes, 34, a temperate and previously healthy man, was admitted into the North Riding Infirmary at Middlesbrough on May 14, for the radical cure of hernia. There were about half-a-dozen persons in the same ward who were ill with the epidemic pneumonia during his stay in it. The ward was well warmed. On May 20 the operation was performed, and on the 29th, being sufficiently recovered to obtain permission, he went out in the afternoon to visit a friend in the outskirts of Middlesbrough, walking to his friend's house, and leaving in the evening to return to the hospital. The day had not been cold (max. temp. 61°), but it became cold towards evening, and the temperature fell in the night to 32° (the lowest night temperature since May 13). There was no case of sickness at his friend's house, where he remained until his return to hospital, and all the refreshment he took there was tea, with two eggs, and a glass of gin and water. He had told his friend that it was his intention to take back with him a sovereign as a donation to the hospital out of gratitude for the relief he had received there; but when nearly at the hospital he found that he had forgotten to bring the money, so hurried back to his friend's house to fetch it, and became a good deal heated and tired with this double journey. The next day he was attacked by the pneumonia, and his temperature in the evening was 103° F. He died of the disease on June 6, on the eighth day of his illness. He would perhaps have escaped altogether, as did others in the same ward, and as did the ward nurses, had it not been for the misadventure of the chill and fatigue of the 29th. (See p. 240; see also temp. chart No. 6).

3. George Walton, aged 62, a millwright, residing at No. 55, Vaughan Street (No. 26, Table XV., p. 298), was attacked by "pneumonia" in May 19. He was attended by Dr. Williams, of Middlesbrough, and died on May 26, on the eighth day of illness.

Mr. William Walton, his brother, aged 56, a temperate man, residing at 7, Fallows Street, paid him, along with his wife, a visit on May 22,

and stayed with him about an hour. On the 23rd they both visited him again and stayed with him about a quarter of an hour. On the 24th William again visited him, but this time alone, and stayed with him an hour. On the night of the 25th both William and his wife were with him from 9 p.m. until he died at 1 a.m. on the 26th, *i.e.*, four hours. On May 28, *i.e.*, two days after his brother's death, William called on Dr. Ketchen in the evening complaining of pain in his left side. His temperature then was 104° F., and Dr. Ketchen sent him home to bed. This was the commencement of an attack of pneumonia from which he died on June 21. The incubation period in this case was probably about two days, since it was on 25th that he spent the longest time with his brother, and as the latter was then dying was probably brought into closest personal contract with him. Mrs. W. Walton was not attacked, nor was anyone else in the house. [It was in George Walton's house that a lodger was attacked on June 2.]

4. John Friar, aged 22, who resided in Cleveland Cottages, a court leading out of Durham Street, was a son of Mrs. Burns, the keeper of the common lodging-house, 10, Durham Street (see Table XV., No. 15, p. 295). When the first cases (Smith and Witham) occurred at No. 10, Durham Street, this young man assisted in nursing them. On March 8 he took Smith in a cab to the workhouse infirmary, and on March 10 he similarly took Witham to North Ormesby. On March 13, he came to live with his mother, and was put to sleep in the back attic. He was taken ill the next day, March 14, and passed through his illness at his mother's house. He died on March 20, on the seventh day of illness. The incubation period in this case is likely to have been at least four days. His mother, who attended to him, was taken ill on March 19.

5. Rev.— Rowland, vicar of St. Peter's, Middlesbrough. See Case XIV., p. 306. If Mr. Rowland was infected directly from Stevens the period of incubation could not have exceeded 15 or 16 hours.

6. Mrs. Harker, aged 55, residing at 37, Princess Street, a stout woman, subject to attacks of bronchitis and always a little wheezy, was on April 3, at 7 a.m., called out of bed to go down the street to see Thomas Black, of No. 20, Princess Street (Table XV., No. 20, p.), as the people at No. 20 thought he was dying. She stayed with him about an hour and went to see him again two or three times during the course of the day. On April 4 they sent for her out of bed again at 5 a.m., and she stayed with the patient until breakfast time. She was taken the next day, April 5, with shivering, and on the 6th sent for Dr. Hedley. Accustomed to her bronchitic attacks, both he and his assistant regarded the case as one of recurrence of her old ailment, knowing nothing of the events just described. Her fatness naturally rendered the diagnosis by physical signs difficult, and Dr. Hedley says there was no distinctly pneumonic expectoration. She died on April 10, on the sixth day of her illness.*

7. Mrs. Robinson, a sister of Mrs. Harker, residing at 45, Russell Street, sat up with Mrs. Harker on the nights of April 6 and April 8, and more or less nursed her sister during her whole illness and until

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* Since this was written I have learned from Dr. Ketchen that the household consisted of Mr. Harker, a labourer, who died from an attack of pneumonia on March 10, 1889 (exactly 11 months after his wife), Mrs. Harker, and three sons. Mrs. Harker was nursed by her sister, Mrs. Robinson, and by a married daughter who resided in another part of Middlesbrough; and a charwoman was in and out of the house during the illness. Of all these persons Mrs. Robinson alone was subsequently attacked.

she died on April 10. She herself was attacked at 3 a.m. on April 11, the day after her sister's death: her illness commenced with rigors: she was under the care of Dr. Ketchen, and ultimately recovered after a prolonged convalescence.

8. John Morley, aged 21 years, residing at 22, Thomas Street, assisted in nursing his brother-in-law, John Knowles, aged 29, who resided at 18, Thomas Street, and who died under Dr. Bateman's care from double pneumonia on February 29,—having been taken ill on February 18. Morley was a man of splendid physique and of regular, steady habits. His illness commenced on February 26, the ninth day of his brother-in-law's illness. At first the physical sign of pneumonia could not be detected: his early symptoms were abdominal, very frequent and offensive diarrhœa, with a tumid and tympanitic abdomen, a temperature of 105° F. At the commencement there was dry, brown tongue, and intense headache; but after about a week the signs of pneumonia on one side became distinct. As he was convalescing a relapse took place and the other lung was invaded. After a prolonged illness he recovered, having lost at least four stones in weight.

9. Mary Carley, aged 56, residing at 25, Commercial Street, was mother-in-law to Morley, visited him during his illness, and sat up nursing him one night, believed to be March 3. She was attacked by pneumonia on March 5, was attended by Dr. Bateman, and died on March 9. The incubation in this case was probably, therefore, about two days.

10. Jane Roxborough, aged 64. This is Case III., p. 300.

11. Sarah Taylor, aged 56, residing at 8, Spark's Yard. At 9, Spark's Yard (next door), a boy named Frederick Shaw, aged 9 years was first seen by Dr. Bateman ill with pneumonia on May 15. On May 22 he is stated to have been convalescing. He lived with his grandmother, and it is stated that, with the petulance of a sick child, he would not allow anyone else to do anything for him. During his whole illness he was never upstairs in his bed, but lay rolled in a blanket on chairs near the fire in the downstairs room. Mrs. Taylor during this time was constantly in and out of this room assisting Mrs. Shaw in household matters, and must consequently have been in personal relation with the boy, although in not such close and frequent contact with him as his grandmother. The small size of the rooms in these poor cottages must be kept in mind. Mrs. Taylor was attacked by pneumonia on May 24, the 10th day of the boy's illness, was attended by Dr. Bateman, and ultimately recovered. The grandmother escaped illness.

(*b.*) *Mediate Infection, especially within Dwellings*:—As to the part played by *attachment of contagium to premises*. In connexion with this mode of spread I may refer again to Table XV. p. 292. The occurrence of multiple cases in a house may be due to all the persons attacked therein having been exposed to the operation of the same extraneous cause, to direct infection through the air from person to person, or, thirdly, to infection by means of the contagious principle remaining attached to the premises, their contents, or their appurtenances. In the first case it would be expected that the cases would occur pretty nearly at the same time, except where such articles of food and drink as water or milk from a continuously infected source were habitually in use in the house; in the second case we should look for the after-

attacks taking place amongst those most closely associated with the sick, persons nursing them or coming into closest personal relation with them; in the third case we should expect to meet with attacks at a later date, after such a lapse of time, for instance, as would probably exclude either of the above modes of transmission of the contagium. Among the "contents" of the house that the sick may be regarded as possibly infecting must be mentioned "food," and among the appurtenances, drain catch-pits, privies, and receptacles for ashes and refuse. Looking through Table XV., p. 292, the succession of attacks would appear consistent with this third mode of acquiring infection in Nos. 2, 3, 4, 5, 7, 8, 11, 12, 14, 15, (21 ?), 26, and 27. It certainly strengthens a belief that the disease may be communicated in this way, to find among 29 instances of multiple cases in a house at least 12 in which this mediate mode of communication may very possibly have been operative. The most striking of these instances, looking at the period that had elapsed since the preceding case in the house and at other circumstances, are No. 2 where 3 months elapsed, No. 3 where about 6 months elapsed, No. 4 where nearly 4 months elapsed, No. 5 where about 6 weeks elapsed, No. 8 where about 3 months elapsed, No. 11 where about $2\frac{1}{2}$ months elapsed, No. 12 where nearly 3 months elapsed, No. 14 where the person attacked was a new occupant of the dwelling and was attacked after a lapse of 2 months from the death of the preceding case, and No. 15 (Williamson case) after a lapse of about 7 weeks from the removal of two pneumonia patients from the sleeping room he afterwards occupied.

(*c.*) *Mediate Infection, especially outside of Dwellings*:—As respects possible operation in the *dissemination* of the disease (*i.e.*, of the infective bacillus) of *sewers, drains, and receptacles of filth*, it has to be borne in mind that the sputa (if not other discharges from the sick) must have been disposed of either into privies or ashpits or have passed through the medium of yard gullies into private drains and thence into the sewers of the district, and that the sputa at any rate have been shown by Dr. Klein to contain the bacillus pneumoniæ, which he regards as the *vera causa* of the disease. Under the circumstances, anyone who has studied my description of the drainage and the privy and ashpit arrangements in Middlesbrough and in the adjoining Local Board districts, will require little assistance in apprehending how well adapted those arrangements are to promote the extension of a malady due to a morbific material, liable to be introduced into them. Among contrivances for assisting spread of such material of this class, I may enumerate instances as follows:—(*a.*) the universal adoption of a form of yard-gully trap in which a deposit of filth takes place, and in which it may be retained for an indefinite period,—the filth in the trap, when the latter is emptied, being merely transferred from the trap to the ashpit where it is capable of being almost equally mischievous; (*b.*) the practice adopted (except in newly-built dwellings) of carrying the sink pipe from within the house actually into the gully trap outside, with the result of providing a channel by which effluvia therefrom may readily enter the dwelling; (*c.*) the intercepting sewers of Middlesbrough, which are "tank sewers" for the most part, and retain within them the sewage for some hours twice a day; and (*d.*) the presence everywhere in the infected districts, except in the newer parts of Middlesbrough, of manholes each provided with a cesspool or receptacle for collecting deposited filth. Further, in this connexion is the consideration that owing to the rapid rate at which the towns have

been built, the presumption is that it must have been physically impracticable for any surveyor of a Local Authority, however competent, to exercise due supervision of and control over the mode of laying of all the drains, or over the making connexions of all drains in domestic premises so as to ensure that all junctions should be made, and should remain, water and air tight, and that all drains were laid at proper levels and gradients. Finally, there is the unsatisfactory method of emptying privy ashpits, and of emptying and cleaning privy pans or boxes where this system has been introduced by Local Authorities. All these faults and mistakes were calculated to promote the spread,—within the house, from house to house, and from one to another part of the district,—of any disease the discharges of which were poisonous on account of their containing the material and specific cause of the malady.

There can be no question that the mortality was greatest in those districts of the infected area, and in those subdivisions of the several districts (so far as I have been able to define them), in which unwholesome local conditions of the sort I have enumerated most abounded. I may especially mention (see Table U., p. 215) the northern division of the town of Middlesbrough, South Bank, and the south-eastern division of Middlesbrough. As regards the last-mentioned division of Middlesbrough, it is certain that the highest mortality prevailed in that part of it, included between the Boundary Road, Newport Road, and the railway, where the drainage arrangements are less satisfactory (see p. 167), than in other newer portions of the same division of the town.

Further, the relation between the rise and progress of the epidemic and the alternations of drought and rainfall mentioned at p. 214 would seem to indicate that the disease spread most at times when the contents of the drains, traps of deposit, and sewers were stagnant from deficient rain-flushing, and spread least at times when their deposits were most likely to have been washed away by falls of rain, especially by the heavier and more abundant falls of rain. It is also worthy of remark (see Table III.) that at the height of the epidemic, in the four weeks ending June 16, when the drought was greatest and the drains, sewers, &c., owing to the abundance of the pneumonia, most charged with morbid material, old people and women, who are most at home and so most likely to be constantly exposed to emanations about their dwellings, suffered in a larger proportion to the males and younger persons than at any other time. From my account of the epidemic as it affected the Union Workhouse, p. 241, it will later on appear that in this institution the disease was probably spread mainly by the kind of influence now under consideration.

There exist two diseases of the zymotic class, viz., enteric fever and "diarrhœa," prevalence of which are, under ordinary circumstances, pretty sure indication of prevalence also of the unwholesome conditions of the sort above referred to; and as matter of fact I find that both epidemic maladies have prevailed more in the northern section of Middlesbrough than in the rest of the borough. Taking the mortalities for the years 1885, 1886, 1887, and the first half of 1888, for the reason that rates have to be calculated on the populations in 1888, of separate subdivisions of Middlesbrough,*—the deaths from these diseases and the rates for the several subdivisions were as follows:—

* It is only for 1888 that I possess these estimated populations, but the proportions would not have been seriously different in the years in question.

Enteric Fever.

Middlesbrough.	1885.	1886.	1887.	1888 to June 1.	Total.	Rate per 10,000 estimated Population.
North section - -	4	6	5	1	16	9·0
South-east section -	8	5	3	4	20	7·4 } 7·2
South-west section -	5	4	6	2	17	6·9 }

Diarrhœa.

North section - -	11	24	6	7	48	27·1
South-east section -	5	19	12	3	39	14·5 } 16·5
South-west section -	5	20	10	10	45	18·3 }

Enteric fever and diarrhœa are, as has been said, diseases which are known to be spread by emanations from the earth, from defective or badly-constructed sewers and drains, and from accumulations of filth, when there is present in one and other of them the contagious principles of these maladies. And on the whole the distribution in Middlesbrough of the "pneumonia" of 1888 corresponded with the distribution there of these other diseases during recent years.

(*d.*) *Spread of the disease through the medium of drinking water* is put out of the question by the fact that besides Middlesbrough and the other infected districts, Stockton and Redcar are supplied by a continuous main from the pumping station on the Tees. Redcar is most distant from this pumping station, Middlesborough and the infected districts intermediate, and Stockton nearest to it; yet neither Stockton nor Redcar suffered from the epidemic.

The Inhalation of "Slag-dust" and other kinds of Factory-dust as a Cause of the Epidemic.

There is but one establishment in the whole infected district where the crushing and sifting of the slag from the converters used in the Gilchrist-Thomas process is carried on, namely, the North-eastern Steel Company's works situated at the very angle of the bend of the river at the north-western corner of the borough, on the land mentioned as entirely occupied by iron works. Of all the manufacturing works, the North-Eastern Works are the most distant from the town and infected districts, and nothing but a north-westerly wind would bring even the smoke of these works into the town. *A fortiori* the slag-dust having a sp. gravity of 3·012 would not be expected ever to get there at all; and even with a high wind none could be expected to reach the outlying places where the epidemic prevailed. Moreover, in so far as the epidemic malady has been shown to have been a specific disease, the *vera causa* of which was a living micro-organism (such as a slag from a furnace could hardly have contained), any influence that the slag could have exerted could only have been an assisting influence at the most, and would only as such have been operative within the part of the works devoted to the crushing and sifting and its immediate neighbourhood.

Now during the epidemic period there were altogether constantly employed at the North-eastern Steel works from 850 to 900 men. At the mill where the slag is crushed and sifted 16 men and 4 boys are constantly employed. I have not been able to ascertain precisely the number of cases of pneumonia which occurred among these operatives, but the number of deaths from pneumonia among them is stated by Mr. Cooper, the obliging manager of the works, to have been 10. Of these, Mr. Cooper says three were men engaged daily at the slag mill,

two of them in oiling and looking after the machinery, and one in feeding the mill. This would leave seven deaths among men engaged in other parts of the steel works, converting, rolling, or labouring in various ways, mostly under cover, but exposed to great alternations of temperature, draughts, &c. Proportionally, then, the deaths among the slag workers were greatly in excess of those in the other parts of the works, but the number of the former class is so small as to invalidate the comparison in some degree. The deaths among the slag workers were 15 per cent. of the workers, and among other employés and labourers about 1 per cent.—the rate for the entire infected district of persons over 15 years of age having been 0·7 per cent. of the population living. If the number of deaths given me by Mr. Cooper be even approximately correct, the total mortality of the North-eastern works (10) was about 1·2 per cent. of the workers of all kinds.

Both classes of the Steel Company's workers work in a dusty atmosphere, but the dust in the slag mill, either from the quantity of it in the air or from its quality, is much more irritating to the lungs than the dust in the other parts of the steel works. In both cases much of the dust is metallic, but in the latter it does not accumulate in a confined space, as the sheds where the work goes on are open all round, while in the slag mill it accumulates in the chambers and forms a layer upon the floors, which is disturbed by passing to and fro over them and by every movement upon the surface.

The following is an average analysis of this "slag-dust" as given me by Mr. Cooper:—

Lime	45·04 per cent.
Magnesia	6·42 „
Alumina	1·50 „
Peroxide of iron	2·10 „
Protoxide of iron	15·42 „
Protoxide of manganese	3·50 „
Protoxide of vanadium	1·35 „
Silica	5·80 „
Calcium	0·40 „
Sulphur	0·32 „
Phosphoric acid	18·10 „

The phosphoric acid is combined with lime in the form of a tetraphosphate of lime. The iron probably exists in the form of magnetic oxide intimately mixed with the other elements of the slag, since I found that nearly all of the powdered slag as sold could be taken up by the magnet.

Mr. Cooper tells me that, of the men now engaged at the steel works, those who suffer most inconvenience from dust are the men engaged in loading freshly burned lime for the furnaces, and these habitually cover their mouth and nose with a handkerchief while at work. No respirator of any kind, however, is in use within the slag grinding building.

I had some personal experience of the irritating quality of the dust within the building appropriated to the crushing, sifting, packing, and storing of the slag, the part designated generally as the "slag-mill." I visited the mill in company with Dr. Malcomson and spent nearly an hour within the building studying the process. While there I felt no inconvenience, but in the evening suffered from a tightness of chest, sonorous wheezing, and cough with mucous expectoration, which lasted for some 24 hours. Dr. Malcomson suffered similarly and Mr. Cooper says that he is affected in a similar manner whenever he spends half an hour or more within the building. But there is nothing in all this peculiar to this particular kind of dust; it is a common train of symptoms enough as following a similar exposure to the inhalation of

other kinds of fine irritating dust; and Dr. Malcomson remarked that he had experienced precisely the same effects from spending a like time in flax mills in Ireland.

There are a few other places in the kingdom where the slag from the Gilchrist-Thomas converters is ground and sifted. As to one of these, namely, the Glasgow Iron Company's works at Wishaw, I have been able to obtain information. Dr. Robert Livingstone, the certifying factory surgeon of the district, parochial medical officer, and medical attendant of the works, writes me on April 4, 1889: "The work has been "in operation for upwards of a year, and neither my brother nor I, "who are both medical officers of the company, have observed any cases "of epidemic pneumonia amongst the workmen, and certainly no cases "have hitherto occurred which I could trace to this cause."

But curiously enough shortly after the commencement of the inquiry at Middlesborough, I received a letter from Dr. G. Ollive, of Nantes, informing me that a very serious epidemic of pneumonia had in June broken out among the workmen at an establishment there, at which phosphated slag mostly from Middlesbrough is crushed and manufactured into a manure by mixing with other matters; and that the cases of the disease he had treated at the Hôtel-Dieu were of an exceptional malignity. About 100 men are employed at these works. Subsequently he informed me that the works having been closed for a time the epidemic ceased and did not re-appear when they were re-opened. Dr. Ollive published in the "Gazette Médicale de Nantes" some account of this local epidemic. The account given of cases observed by Dr. Ollive is similar both clinically and pathologically to that which I have given above (p. 200) of theMiddlesbrough cases. Dr. Ollive adds, "while I "had the cases from the manure works under observation, pneumonia "was prevailing in Nantes, but there was an important distinction "between the two classes of cases. Those from the works were of "exceptional gravity; of 3 cases under my own care at the hospital "2 died, and of a total of 13 admitted, 11 died. During the same "time they had in the medical wards at least 14 cases of pneumonia "unconnected with the works, all of which recovered. The first case "from the works was admitted on May 28 and the last on June 26. "About the same time the pneumonia in the town at large greatly "diminished, and the admissions into the Hôtel-Dieu were much "reduced in number."

It would appear from this account that the cases among the men at the factory were part of a general epidemic prevailing in the town during May and June. It is not obvious, although (from the relative proportions of workpeople and others not occupied at the numerous works who were admitted with pneumonia) it is probable that the persons thus employed were more extensively attacked than the rest of the population in the town; but there is no doubt upon one point, namely, its extreme and exceptional fatality among the factory operatives.

No opinion can be formed as to the *vera causa* of the Nantes epidemic, but the low fatality among non-operatives would lead to the belief that it was not the same as at Middlesbrough. Nevertheless, even in this Nantes epidemic of low general fatality, the operatives exposed to the inhalation of the slag dust suffered with exceptional severity. Chemical examination of the expectorated matters in one of the operative cases showed that they contained oxide of iron and lime. This was to have been expected.

The general inference which is to be drawn from all these observations in Middlesbrough, Nantes, and Glasgow appears to be this, viz., that in itself the phosphatic slag dust, irritating though it is, is not

a cause of pneumonia, but that when from any cause pneumonia becomes epidemic, persons largely exposed to the inhalation of its dust may, and do, suffer more than persons not so exposed, and that the disease with them is of high fatality.

Another kind of dust, evolved as a reddish-brown smoke from a tall chimney of Bolckow Vaughan & Co.'s Spiegel Ironworks, was complained of to me by some persons residing near these works as having had a share in the production of the epidemic in that part of Middlesbrough. The dust occasionally falls round about the works within an area of a few hundred yards. By far the greater part of the dust, however, is deposited in the flues leading to the chimney, and at the bottom of the chimney itself. There is no allegation that the workmen who once a week clean out this dust had suffered more than others from pneumonia; indeed nothing had been heard at the works of any of them having been attacked. The following analysis of the brown dust deposited at the bottom of the chimney referred to was obligingly given me by the chemist of the works:—

Oxide of iron - - - -	1·81
„ zinc - - - -	10·00
„ manganese - - -	30·85
Alumina - - - - -	7·00
Silica - - - -	20·60
Lime - - - - -	6·60
Magnesia - - - - -	2·00
Potash and soda - - - -	8·60
Carbonaceous matter (coke dust) -	0·70
Sulphuric acid - - - -	11·66
	99·82

It is clear that this dust could have had as little to do with the causation of the epidemic as the slag dust of the North-eastern Company's works. Still it is not improbable, although I am not in a position to assert it confidently, that the dust prevailing in the atmosphere of the iron and steel works which abound in the infected districts may have, as it were, prepared those greatly exposed to it to suffer from the epidemic influence more than others not so exposed.

[See further on this subject the analysis of cases occurring at the Cleveland Dockyard, p. 240.]

Exposure to Cold and Chills, or Weather Influence as conducing to the Epidemic.

Reference has already been made (p. 213) to the sudden variations in climatic conditions to which Middlesbrough and the neighbouring districts are subject, and to my own experience of these variations during the latter part of the epidemic period, as well as to the recklessness of many of the labourers who, after spending their hours of labour in the heated atmosphere of the works, expose themselves to chills by loafing about street corners and public-houses after leaving their work. It cannot be supposed that this habit alone was the cause of the epidemic, for it has for years been a common-place practice, and probably in other iron-making towns where there has been no epidemic pneumonia the practice is very similar. But in the presence of an epidemic influence of any kind such a habit is an element of danger as disposing the persons so exposing themselves to suffer from it. This sort of influence of chills is nothing new in medical experience, whether as determining the morbific operation of the true cause of a specific disease or imparting to its operation a fatal character. Medical men commonly

hear of chill from exposure to cold or cold and wet as preceding by a longer or shorter interval an attack of such diseases as erysipelas, scarlet fever, enteric fever (very commonly), diarrhœa, &c., indeed so often as to lead medical men to believe that such exposures have some sort of assisting influence. It probably was so in some instances during the course of the Middlesbrough epidemic. It was not mentioned in many of the cases that I visited, but this may have been because it was too common an event to be particularly impressive, especially on the minds of people who had possessed themselves of another notion of the cause of the disease. But a few of my cases point to such an influence having existed. Possibly Case IV. (page 301) was one of them. There was a north-east wind that day, and the temperature, which reached 69° in the daytime on June 15, fell considerably towards evening, reaching a night minimum of 34°. Case V. was in a man much exposed to cold at his work, and his hoarseness when he was first seen seems to indicate that he had taken cold. He was taken ill in the night of Sunday, June 10. Two days before, viz., on Friday, June 8, the day temperature was as high as 70°, but fell afterwards to a night minimum of 39°. Cases XI., XIII., and XXV. are cases which certainly had recently been exposed to chills. The case of James Maynes, referred to at p. 231, is also to the point. This man had been exposed for some weeks to the contagium of the disease in the warm ward of the infirmary, but together with other occupants of the ward and the nurses escaped attack until his unfortunate visit to a friend and the exposure and fatigue which terminated his outing.

Another class of evidence also bears upon this point. Messrs. Dixon, Middlesbrough, who are large iron ship builders, of Cleveland Dock-yard, employing during the epidemic period about 1,000 men, kept an account of their employés who were attacked by the epidemic illness, and have been good enough to furnish me with a list of those attacked, stating the work in which each man was engaged, and whether it was out-of-door work, including work done in open sheds, or indoor work done in workshops where the men are protected against exposure to the weather, but where some of them work in an atmosphere dusty either from wood dust or metallic dust. Mr. Waynman Dixon tells me that the number of men working outside "shops" is probably twice the number of those working inside. The following is an analysis of the list of cases:—

Occupation.

Working Outside or in open Sheds.	Cases.	Died.	Working within closed Workshops.	Cases.	Died.
Platers	1	1	Angle Smiths	2	2
Rivetters	7	6	Smiths	3	1
Riggers	1	1	Joiners	4	3
Caulkers	1	1	Fitters	2	2
Drillers	4	1	Painters' shopman	1	1
Carpenters	3	2	Storekeeper	1	1
Helpers	2	2	Weighman	1	—
Labourers	1	1			
Painters' shopman	1	1		14	10, or 71·4 per cent.
	21	16, or 76·2 per cent.			

The greater number of these men, if not all, were, Mr. Dixon says, strong healthy men in the prime of life. Their ages varied from 27 to

61 years. It is to be observed that not a single case occurred among the clerks in the office nor among the draughtsmen.

If Mr. Dixon's estimate be correct that about twice as many men were employed outside and in open sheds as were employed in closed workshops, it would not appear that mere exposure to cold and draughts had much to do with the attacks, since, in proportion to the numbers, those engaged in close workshops suffered to a greater extent than those who worked outside. Probably the dusty atmosphere of the shops in which some of the former work had something to do with the greater extent to which these men suffered,—dustiness due to fine wood dust with which the atmosphere is necessarily more or less charged in the joiners' shops for instance, and metallic dust in the smiths' workshops. If this be so, it would appear that exposure to the inhalation of dust had more to do with the attacks than severe exposure to cold and draughts.

As regards the extent to which the workmen at the Cleveland Dock-yard were attacked it would appear to have been very much greater than the extent to which the population of the entire infected district at similar ages was attacked. In the former instance the attacks were about 35 per 1,000 persons, and in the latter about 20 per 1,000 living. It is unfortunate that I cannot compare with this the number of attacks per 1,000 among the workpeople at the North-eastern Steel works.

But as regards fatality from the pneumonia at the Cleveland Dock-yard, it was obviously inordinately high, being on the whole 35 cases 74·3 per cent., a fatality greatly exceeding even that of the paupers at similar ages admitted from outside for treatment in the workhouse infirmary, viz., 46·3 per cent. It would appear, then, that altogether the conditions under which these employés worked were such as not only to render them more liable to attack than the population generally, but more liable to die from their attack. Nor indeed was there on the whole any very remarkable difference in the fatality of the pneumonia among those working outside and those working in closed workshops. Whatever caused greater liability to attack, whether it were exposure more or less to the weather or exposure to the inhalation of a dusty atmosphere, seems to have imparted also a greater liability to die from the malady.

But the Table (p. 240) seems, when studied, still more closely to indicate a difference even here. For of the 21 outside workers the "drillers," who work under sheds, suffered a much smaller fatality than the rest, most if not all of whom, and certainly the "rivetters," "riggers," and "caulkers," are exposed in their work to the rain and damp, as well as to cold.

The Union Workhouse.

This appears the proper place for giving an account of the epidemic as it occurred at the Union Workhouse, which is situated within the borough about a mile from the centre of the town of Middlesbrough, and in what is practically a rural district. The account cannot be dispensed with, because of its bearing upon the etiology of the disease.

General Sanitary Condition of the Workhouse Buildings.—The Middlesbrough Union Workhouse is a comparatively new building, which was first occupied at the end of December 1878. It consists of three series of separate buildings constructed *en echelon*, the southern-most blocks containing the master's residence and offices, kitchens, store-rooms, laundries, with the day rooms and dormitories of the healthy although it may be infirm inmates; the northernmost blocks

containing the day rooms and dormitories of the children, and the intermediate blocks the workhouse hospital and infirmary. The whole is provided with a system of drainage which up to the time of my visit was believed to be satisfactory. The water supply for domestic and drinking purposes is one laid on, on the constant system, from the mains of the same company that furnishes the supply to the town of Middlesbrough. I found in the possession of the guardians two ground-plans, each professing to show the course of the drains, but they did not correspond. One apparently, judging from the signatures attached to it the official plan, was obviously and admittedly incorrect as representing what was actually carried into effect; the other plan, subsequently made, and believed to be correct, was in various respects inaccurate, although more closely representative of the real drainage arrangements than the official plan. What is certain about the matter, however, is this, that at the time of the epidemic there was existent,—passing through the area of the workhouse grounds (on the west side from the school buildings at the north) to the public sewer in the main road,—a large drain or sewer, which in its course received at certain spots subsidiary drains from the several blocks of buildings and their appurtenances. There was free air communication between the public sewer in the roadway and this main drain, and between it and all the subsidiary drains. In the course of the main drain were three man-holes corresponding to the places at which the principal drains from the three blocks entered the main drain, and at these spots there were ventilating openings. But while the bottoms of the northernmost and middle man-hole were completed with a brick invert, or the segment of a pipe, the bottom of the southernmost man-hole, through which the sewage of the whole of the buildings had to pass on its way to the road sewer, was apparently not so made impervious, since here there was existent a pit, beneath the level of the main drain, in which a filthy mud accumulated, which pit may have been occasioned by the frequent acts of removal of deposits happening at this spot, or it might have been there originally. On the occasion of my first visit to the workhouse I found that some illness in the master's family had been attributed to drainage defects in his lavatory; and my suspicion that the drainage of the building had been scamped in some way was aroused, not only from this fact, but from my discovery that at the first bath-room that I entered on the ground floor, the bath water when let off did not flow out by a pipe apparently provided to discharge it over a trapped gully outside, but into the basement of the building. Other drainage defects and faults in the provision for carrying off slops, &c. from the upper stories attracted my notice at the same time, and I consequently induced the guardians, through their chairman, to obtain from an expert inspector attached to a sanitary institution at Newcastle a report upon the whole matter. From the report which was made by this expert, Mr. McChlery, C.E., it may for my present purpose suffice to make the the following extracts. [A copy of the entire report I forward with this report for the fuller information of the Board.]

"The courses of the drains are shown on a large plan" [the non-official plan mentioned above which was in Mr. McChlery's hands during his inspection], "but it is, however, slightly incorrect and does "not record many watercloset and gully connexions. *Remark.*—It is "very important that a clear and true plan of the drainage of such a "large building should be provided, and I would now advise that the "necessary correction should be made to it and *kept up to date.*

"Smoke Test.—Applied at a gully connexion with each main branch "drain and the main drain.—From this test it was proved that the "gases from a long and foul drain, and from the main sewer in the

"Cemetery Road, were escaping freely and directly into the inside of "buildings at master's lavatory, womens' bath-room, infants' ward, "mens' day-room, and tramp ward bath-rooms, and escaping indirectly "(from the very defective gully connexions) through the untrapped "waste pipes to inside of all the bath-rooms which are directly adjacent "to the dormitory, &c.; while also it was proved that the gases are "escaping at every gully and soil-pipe connexion around the premises, "some of the connexions being close under windows and ventilators "under the floors, &c. [How much these *et cetera* mean is left to the "reader's imagination.]

"Main Drains.—The drains are constructed of 9″ and 12″ glazed "pipes, and led as per plan to join the main sewer in the Cemetery "Road.—The drains throughout are very sluggish, and contain a "considerable amount of putrefying matter due to insufficiency of fall "and excessive size of pipes. The main drain has also apparently not "been laid to a true gradient throughout, as it contains 2 inches of "still water at the centre man-hole, the drain serving for the north "section of the hospital being especially sluggish. The direction of "the drains serving for the scullery, washhouse, &c. is very objection-"able, as the flow of water in the main drain is impeded, causing "obstruction, and sewage to collect in the drain. The drains have "been jointed with clay, which is not a reliable material, as the clay "is liable to be washed out of the joints and the pipes to get displaced, "leaving openings at the top side of joints for foul air to escape: the "subsoil here, however, is of solid clay which will prevent any serious "percolation taking place." [I am not sure that Mr. McChlery is altogether correct here, since I was shown in the basement of the main (southernmost) building a well which gathered water from the locality, and had from time to time to be pumped out.] "I may state, however, "that many of the branch drains from the gully connexions have no "jointing material, and in many cases the pipes have not been con-"nected; and, as the subsoil at these points is of loose material, "percolation may be taking place to a great extent. * * * "Main "drains untrapped and ventilated by soil pipes.—It is very objection-"able that the foul gases from the main sewer in the Cemetery Road, "and such a long length of foul drains, should be allowed to circu-"late through pipes with which internal fittings are connected." [As a fact, which I saw myself, the arrangements in the dormitories and all the upper rooms, including the hospital building, were such that any foul air passing up the soil pipes gained the most ready entrance to these rooms.] "The outlet man-hole being constructed to retain "putrefying matter for the cultivation of disease germs is also very "objectionable."

Mr. McChlery's report goes on to point out very serious faults in the master's watercloset, lavatory, and bath-room, and in the drains into which they discharge, faults by which foul air from the drain necessarily escaped directly into the interior of his dwelling.

The report, in addition, points out more or less serious faults about the baths and lavatories in the buildings generally, the arrangements being such as to "simply supply the building with tainted air," as also generally about the waterclosets. As to the latter, he says, "I noticed "also that in many cases the connexions of the service pipes to basins "are leaking, and the connexion of the lead pipe from the basin to the "metal junction in soil pipe was very defective, allowing foul gases to "escape inside direct. As these closets are in direct connexion with

"the dormitories, &c., it is highly important that they should be of the "most cleanly type." As respects the soil pipes, Mr. McChlery says, "the connexions of some of these pipes to the drain have been dis- "gracefully made. I noticed that the joints of one of the soil pipes "serving for the centre buildings [containing the hospital wards] are "all open, no attempt having been made to pack the joints, so that "the gases are allowed to escape in close proximity to windows." Other faults, including faults of ventilation of the buildings, are mentioned, but it is not necessary to carry my extracts from the report further.

The report reveals a condition of affairs and discloses an amount of "scamping" in the construction of the buildings and their sanitary appliances which can only be regarded as disgraceful to all concerned in bringing them about when the buildings were erected.

But the revelations as to the bad drainage of the establishment did not end here; for on receipt of the report, which included recommendations for amendments, Mr. Hunter, the surveyor of the guardians, received certain instructions which resulted in a report or statement of improvements up to its date. [A copy of this report also I enclose for the Board's information.]

From this report the following extract will suffice for my present purpose:—"The work at the boys' and girls' buildings has been only "partially executed: some portions of these branches [drain-branches] "were found not connected with the main drains at all, but had been "laid in common field pipe drains: some of them were found in a foul "condition: some of the branches had been laid with various sized "pipes, both 'sanitary' and common field pipes, and with no regularity "of fall. In some places the sewage had been running into the founda- "tions of the buildings and settling into the ground as best it could."

Nothing was done at this time in the examination of the water-pipes running underground from the main in the public road through the workhouse area to the several buildings. If these were laid as carelessly as the drains, and if their junctions were made as badly as the drain junctions, a further source of possible injury to the residents in the workhouse was provided.

The Epidemic as it affected the Union Workhouse.

Two classes of cases must here be distinguished, namely, cases that arose among inmates of the workhouse (people who had been residing there for a longer or shorter time before their illness) and cases that were sent in ill in order to be treated in the workhouse infirmary. The total number of both classes treated for pneumonia in the infirmary between November 1, 1887, and the close of 1888 was 114, of whom 43 were inmates and 71 non-inmates.

First, as to the prevalence of the pneumonia among *inmates*. It is difficult to ascertain in an institution such as this the mean number of the population. But Mr. W. Bray, the master of the workhouse, to whom I am greatly indebted for much very intelligent assistance in the course of my inquiry, and for a large amount of statistical detail which he has kindly been at the pains of getting out for me in aid of investigation at the workhouse, has given me the following statement, extracted from the workhouse registers.

On January 1, 1888, there were in the workhouse—

Under 2 years of age (in the care of their mothers in the main southernmost building)		33
Between 2 years of age and 16 years of age in the school (*i.e.*, in a separate building devoted to such children) - -	Boys	144
	Girls	142
Above 16 years of age in the main building	Males	306
	Females	149
Total - -		774

On April 1, 1888, there were—

Under 2 years of age - - -		26
Between 2 and 16 years of age -	Boys	129
	Girls	135
Above 16 years of age - -	Males	275
	Females	148
Total - -		713

The average number of inmates during 12 months ending June 30, 1888, were—

697, *i.e.*, under 16 years of age, 395, and 16 years upwards, 302.

On Saturday, July 7, 1888, there were above 16 years of age—

Males - -	214.
Females - -	120.

It appears to me, therefore, that we may fairly take the census of April 1 as approximately giving the mean population of the workhouse, as respects the two sexes in the "schools" and in the other buildings during the epidemic period.

The incidence of the disease upon these four classes of inmates may therefore be stated approximately as follows (calculating the cases under 15 upon the population under 16 years of age). See Table XI*a*. (p. 278) :—

Boys, number	129.	Cases 8, or *per cent.* attacked,			6·2	6·4
Girls, „	135.	„ 9	„	„	6·7	
Males (16 upwards).	275.	„ 11	„	„	4·0	3·3
Females (16 upwards).	148.	„ 3	„	„	2·0	

The incidence of the disease, then, upon the children in the "schools" was about twice that upon the grown-up people, and not very different as respects the boys and girls; whereas, among the grown-up part of the inmates, the incidence on the males was twice that upon the females; but this is a difference which found its parallel outside where grown-up females generally were less liable to attack than grown-up males. But as respects children it is to be observed that while the attacks on the two sexes in the schools was about equal (the excess, such as there was, being among the females), the attacks of female children outside (see Table IX, .p. 273) were less numerous than of males. There was nothing,

so far as I can ascertain, in the management, housing, or feeding of the boys and girls separately to account for this near equality of incidence on the two sexes. It is something which has to be explained.

But another thing to be observed is that the per-centage of attacks upon children was about six times as great as upon children outside the workhouse (see Table P., p. 200), who were worse clad and much worse cared for; and that upon grown-up people in the workhouse it was about half as great again as upon persons of like ages outside, but this last fact may partly depend upon the larger proportion of old persons resident in the workhouse than among the general population outside.

Table X. (page 274) contains a list of the cases of pneumonia treated at the workhouse, distinguishing inmates and non-inmates, as furnished to me by Mr. Longbotham, the medical officer, with the dates of commencement of illness in respect of the inmates and of admission to the workhouse infirmary in respect of the non-inmates. With regard to the latter I must say that many of them had probably been ill a day or two before their admission, but not usually longer. The dates of death have been verified by comparing the dates given in Mr. Longbotham's list with the dates given in the death registers of the Middlesbrough registration district.

In the statistical tables about now to be used I divide the cases (which are too few for dealing with usefully in shorter periods) into those which came under observation during the three months prior to January 29, 1888, those between that date and July 14, and those that came under observation between July 15 and the end of the year, distinguishing inmates and non-inmates, and the sexes and ages. The admissions during three months previous to the epidemic outbreak in each four-weekly period of the epidemic period and in each four-weekly period during the post-epidemic period are indicated by dividing lines in the list of cases in Table X.

Table XI., page 278, shows the number of cases of pneumonia which were treated in the workhouse infirmary, inmates and non-inmates, separately and conjointly, with the numbers of those that died, and the fatality per cent. of the cases, arranged in the three periods indicated by the dividing lines of Table X.

And first, as to all the cases, inmates and non-inmates together. The cases of pneumonia treated during the three months prior to the epidemic outburst which counts from January 29, 1888, numbered 11, *i.e.*, an average of 3·7 per month. Of these 6 were inmates and 5 non-inmates. During the six epidemic months, *i.e.*, from January 29 to July 14, 1888, 80 cases were treated, or an average of 13·3 per month; of these 31 were inmates and 49 non-inmates. During the latter half of the year (*i.e.*, the post-epidemic period from July 15 to December 31), 23 cases were treated, an average of 3·8 cases per month, much the same as during the three months preceding January 29. It is important to note this, inasmuch as we have here some sort of criterion of the prevalence of the disease after it had lost its epidemic feature, a criterion which is wanting in respect of cases in the district generally. Of the 23 cases just referred to 6 only were inmates and 17 were non-inmates.

The fatality of the disease calculated on the whole 114 cases during the whole period from November 1, 1887, during the three months preceding the epidemic outburst, the epidemic period, and during the post-epidemic period, in each sex and in both sexes together, in the adopted age-groups, is represented in the following table drawn upon the lines of Table P., p. 199, and, for convenience, reproduced here from Table XI.*c*, p. 280.

Table V.

Table showing Numbers per Cent. of Cases (Inmates and Non-Inmates of Workhouse together) treated in the Workhouse Infirmary that were Fatal.

Ages.	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
From November 1, 1887, to January 28, 1888.	—	—	—	60·0	50·0	= 57·0	100·0	—	=100·0	100·0	—	=100·0	71·4	50·0	= 66·6	71·4	25·0	= 54·5
1888. January 29 to July 14 -	—	—	—	39·3	50·0	= 40·6	63·2	50·0	= 61·9	77·8	—	= 77·8	53·6	50·0	= 53·2	46·9	18·7	= 41·2
July 15 to December 31 -	100·0	33·3	= 50·0	14·3	50·0	= 22·2	71·4	—	= 71·4	—	—	—	35·3	50·0	= 36·8	38·9	40·0	= 39·1
Mean from January 29 to December 31.	11·1	7·7	= 9·1	34·3	50·0	= 36·6	65·4	50·0	= 64·3	58·3	—	= 58·3	49·3	50·0	= 49·4	45·1	23·3	= 40·8
Mean from November 1, 1887, to December 31, 1888.	11·1	6·7	= 8·3	37·5	50·0	= 39·6	66·6	50·0	= 65·5	61·5	—	= 61·5	51·2	50·0	= 51·1	47·2	24·0	= 42·1

It will be noticed at once on comparing Table V. with Table P., p. 199, and especially with Table IX., how extremely fatal the disease was when treated in the workhouse infirmary, and how very much more fatal was the disease when treated in the workhouse infirmary, than it was when treated outside the workhouse; and that this observation applies both to the three months prior to the outburst and to the epidemic period itself. In point of fact, the fatality in the workhouse infirmary was twice that of the cases treated outside during the epidemic period, and three times as fatal in the three months preceding the outbreak. This may partly be accounted for by the different proportion of children counted into the two Tables IX. and XI.*c.* (from which Table V. is an abstract). In Table IX., 207 of the cases, or 30·4 per cent. of all the cases during the epidemic period, were under 15 years of age, which age-group (0—15) furnishes a very low fatality, whereas in Table XI.*c.* only 18, or 22·5 per cent., of the cases fell into this age-group: but this alone is not such a difference as to suffice to explain the difference of fatality-rate between 41·2 at the workhouse and 21·1 outside. Besides, even if the children be put out of account altogether, similar difference of fatality is noticeable. During the three months preceding the epidemic outburst the cases aged 15 years and upwards treated outside the workhouse died at the rate of 19·6 per cent. of their number, whereas those treated in the workhouse infirmary died at the rate of 66 per cent.; and during the epidemic period the fatality-rate from pneumonia above 15 years of age in persons treated outside the workhouse was 26·5 per cent., whereas in those treated in the workhouse infirmary it was not less than 53·2 per cent. But, again, it may be contended in explanation that there was a larger proportion of old persons treated in the workhouse infirmary than outside. This unquestionably was so. Outside the workhouse 30, or only 6·3 per cent. of the total cases above 15 years of age were above 65 years of age, and in the workhouse infirmary 9, or 14·5 per cent., were above 65 years of age; and, as a matter of fact, the fatality among these 9 was nearly three times that of the fatality among the 30 treated outside the infirmary. So it must be admitted that there is something to be said for explanation in this way. But it is not a sufficient explanation; for the high fatality among those over 65 years treated in the workhouse does not stand alone, since of those attacked during the epidemic period, between 15 and 45 years and treated outside the workhouse 20·9 per cent. died, whereas of those of like ages treated in the workhouse infirmary, 40·6 per cent. died; and of those between 45–65 years treated outside, 37·1 per cent. died, while of those treated in the workhouse infirmary, as many as 61·9 per cent. died. Nor does the different proportion of males among cases treated in the workhouse than among cases outside, account for the higher fatality in the workhouse, for this excess is observable there in both sexes. [It is worth while to say here that the plan of treatment adopted in the workhouse infirmary did not differ materially from that adopted by the medical practitioners generally outside the workhouse (see p. 196), and indeed the comforts and nursing within the building were very superior to those attainable by the same class of persons outside.]

We may now compare the fatality of the cases occurring among the inmates of the workhouse with that obtaining among cases brought for treatment there,* and compare also each series with cases treated outside the workhouse. And first, as to the non-inmates as compared with the inmates, Table XI. *a.* and *b.* (pp. 178 and 179). The fatality of the cases at all ages taken together was greater among the non-inmates

* Cases of this class I shall for convenience refer to as "non-inmates."

than among the inmates. It was, *during the three months preceding the epidemic* outburst, 60 per cent. among the non-inmates and 50 per cent. among the inmates, but in that period two of the six sick inmates were children, and there were no children among the non-inmates. Limiting observation in this pre-epidemic period to attacks over 15 years of age, the fatality was a trifle higher among inmates than among non-inmates from outside; but this may have been due to the former including a case above 65 years of age. The numbers are, however, too small to base any conclusion upon. But in the *epidemic period* the numbers were larger, and here we find that for all ages the fatality was considerably larger among the non-inmates than among the inmates, viz., 47·1 per cent. in the former and 32·3 per cent. in the latter. This again is partly explicable by the ages of those treated in the two series. The inmate series of 31 cases included 17 children, among whom there was not a single death, while the non-inmate series of 49 cases only included one child, who recovered. But looking at the two series, as limited to persons over 15 years of age, we find the fatality among inmates considerably larger than among non-inmates, in the proportion, indeed, of 71·4 to 47·9. One reason for this may be that among the 14 inmates over 15 years of age who were attacked, 6, or 42·9 per cent., were over 65 years of age, and all these six died, whereas among the 49 non-inmates admitted for treatment there were only 3, or 6·1 per cent., who were over 65 years of age, of whom only 1 died; and this well illustrates the greater fatality among older inmates of the workhouse (whose comforts are habitually well attended to) than among similar old people admitted from wretched homes outside. Comparing inmates and non-inmates aged between 45 and 65, there is no practical difference in fatality between the two series, but there is a difference in favour of the inmates at ages between 15 and 45; this, however, cannot be considered as going for much, looking at the fact that the cases of inmates in the age-group were only 3, whereas the cases among non-inmates were 29. In *the post-epidemic period* (during which no case occurred among inmates over 65 years of age) of two cases of inmates between 15 and 65, both died; but among 17 non-inmates over 15 years of age only 29·4 per cent. died, and all of these were under 65 years. Taking the whole year from January 29 to December 31, among persons over 15 years of age, 43·1 per cent. of the non-inmates died and 75 per cent. of the inmates attacked died. Very similar per-centages are obtained when the whole period from November 1, 1887, to December 31, 1888, is considered. There is, then, something yet to be explained with regard to the higher fatality of the disease among inmates than among non-inmates above 15 years of age.

There is also something requiring explanation as regards a higher fatality among persons brought into the workhouse infirmary for treatment than among cases treated elsewhere. The fatality outside the workhouse during the epidemic period was, for persons over 15 years of age, 26·5 per cent., whereas the fatality of persons over 15 years of age brought into the workhouse for treatment during the same period was 47·9 per cent. How was this? It is quite true that some of the cases included among those treated outside were private or contract cases, anyhow not paupers; but very many of these even were persons of the same labouring class, living in the same streets and courts, and treated as club or contract patients. The two series were not sufficiently diverse in these respects to account for the difference in fatality. But the suggestion has been made that the act of removal from their homes was calculated to impart a fatal tendency to cases thus removed. That this is so with cholera is well known. We may therefore, as a criterion in this matter, compare the fatality of non-inmates at the workhouse with the fatality observed at the North Staffordshire

Infirmary, situated in the town of Middlesbrough, and with that at the Cottage Hospital at Ormesby. At these two hospitals together, between January 29 and July 14, 46 cases of pneumonia were admitted for treatment, only one of whom was under 15 years of age, and only four of whom (all of them above 15 years of age) were females. Of the 45 attacks over 15 years of age, 11 died, or 24·4 per cent., which per-centage represents a fatality rather lower than that observed generally in the town outside the workhouse. This, then, does not by any means support the suggestion that the act of removal might explain the high fatality among non-inmates at the workhouse. The act of removal certainly did not, in the case of these hospitals, have any effect in raising the fatality, nor could the difference of age in this connexion explain it. Of those admitted into the two hospitals, 37 were between 15 and 45 years of age, and of these 9, or 24·3 per cent., died, and 8 were aged between 45 and 65 years, and of these 2 died, or 25·0 per cent., whereas at the workhouse infirmary during the same period, of those admitted for treatment between 15 and 45 years of age, 41·4 per cent. died, and of those between 45 and 65, 62·5 per cent. died. Obviously, therefore, in respect both of inmates attacked with pneumonia in the workhouse and of persons admitted from outside for treatment there, the excessive fatality has yet to be explained.

At this point I turn to comparison of the behaviour in the workhouse of the pneumonia of 1888 with the behaviour there of pneumonia in previous years. This necessarily involves now and again (and especially in the matter of fatality) basing of data on small figures, with corresponding incertitude of some of the contrasts instituted: nevertheless the broader indications of the comparison may, I think, be trusted. Table XII. (pp. 281–288), shows—*a*, for inmates, and *b*, for non-inmates (*i.e.*, paupers admitted sick into the workhouse infirmary for treatment), the number of cases of each class treated there for "pneumonia" during the preceding eight years, the number at the several periods of each of those years, at different ages, and as well the number of deaths with the the per-centage of deaths to cases in each instance.

I. As respects *cases* of "pneumonia":

1°. That among *inmates* in 1888 "pneumonia" was, at all ages together, above four times as prevalent as in the average of the preceding eight years, and 2½ times as prevalent as in 1886,—the year of the eight in which it prevailed most.

2°. That this greater prevalence among *inmates* was noticeable both among the children and among the grown-up people.

3°. That among the children *inmates* the "pneumonia" in 1888 was four times as prevalent during the epidemic period as during the post-epidemic period, whereas in the total of the eight years preceding the number of cases in these two periods was not far from equal. The epidemic, then, clearly affected the children as well as the grown-up inmates.

4°. That among *inmates* in 1888, even for the post-epidemic period, the "pneumonia" was nearly twice as prevalent as for the average of the same period during the eight preceding years. The epidemic influence did not cease to operate among the inmates, both children and grown-up persons, even to the close of the year.

The admissions of paupers for treatment may be taken as some sort of criterion of the prevalence of pneumonia outside the workhouse, in the town and neighbourhood generally; and upon this hypothesis I proceed to note—

5°. That among *non-inmates* (*i.e.*, persons admitted for treatment) in 1888, the number was four and a half times the average of the preceding eight years:—it was about three times that of the highest number of admissions in any one of the previous years.

So that the prevalence of the epidemic in 1888 among the inmate paupers was much the same as among the paupers outside the workhouse. This comparison, however, only relates to grown-up persons.

6°. That the *male* admissions of 1888 were, however, disproportionately in excess of preceding years; they were five times the average, whereas the *female* admissions were under four times the average. This serves to indicate once again that the 1888 epidemic affected the male population more than did the current pneumonia of former years.

7°. That even in the post-epidemic period of 1888 the pneumonia *admissions* were three times as great as in the average of the same period during the eight preceding years. This again indicates that the epidemic influence had not ceased to operate outside the workhouse, even during the last six months of the year.

II. As respects the *fatality* of the "pneumonia"—

1°. That among *inmates* of the workhouse, the fatality of "pneumonia" in 1888 (as a whole) was considerably higher than the average fatality of the preceding eight years. But this observation only applies to persons over 15 years of age, for the fatality among the children (taking the whole year together) was in 1888 very much below the average.

2°. But the fatality of the pneumonia among *inmates* at one and another age, in 1888, differed widely also, both in the epidemic and post-epidemic periods, from that of previous years: thus,—

In the *epidemic* period of 1888, out of 17 *children* attacked not one died, whereas in the corresponding period of preceding years 12·5 of those attacked died. On the other hand, in the *post-epidemic* period of 1888 half the *children* attacked died against 15 per cent. in the corresponding period of preceding years.

Further, of persons *aged 15–45*, the fatality of "pneumonia" in the *epidemic* period of 1888 was half that of pneumonia in the corresponding period of eight preceding years, the excess observed at *all ages* over the previous average being confined to attacks over 45 years; indeed, all over 65 years attacked in the epidemic period of 1888 died, as against 40 per cent. at such ages in preceding years. On the other hand, in the *post-epidemic period* of 1888 neither of the two cases in grown-up people recovered (both were, however, under 65 years of age), whereas in previous years all four grown-up people attacked under 65 years of age recovered. It is obvious, then, that in 1888 the pneumonia among inmates, both young and grown-up, continued to be characterised by unusual fatality, even after the epidemic prevalence of the disease so greatly subsided as to be little perceptible in the general population.

3°. That among *non-inmates* (persons admitted from outside for treatment) during 1888, all but one of whom (a case that recovered) were over 15 years of age, the fatality was only a trifle greater than that of the pneumonia cases at all ages admitted in previous years.

4°. But there is this remarkable difference to be noted between the fatality of the disease among inmates and among non-inmates as regards the epidemic and post-epidemic periods separately—

In the *epidemic* period of 1888 the fatality among the non-inmates was considerably higher than the average fatality in the same period of eight previous years, whereas—

In the *post-epidemic period* it was considerably lower than in the corresponding period of the eight previous years.

In fact, among these cases admitted from outside for treatment, the fatality was in 1888 a remarkably decreasing element as time progressed from November 1, 1887, or January 1, 1888; whereas in the average of eight former years the fatality was little different as the year progressed, and if anything, rather an increasing element.

Upon the whole the above comparisons would seem to indicate that really the pneumonia of 1888 differed in important respects from disease passing under the name of pneumonia in previous years.

Causation of the Disease in the Workhouse.

The first thing to be accounted for is the occurrence of the epidemic in the workhouse at all, seeing how this is isolated amidst fields a long way from the populous part of the union and borough of Middlesbrough, and in a part of the borough, moreover, which suffered less from the epidemic than other parts, though it did suffer from it to some extent. In explanation of this I must refer to the evidence adduced that the disease was in one or another way a communicable disease, and to the further fact that although the buildings are isolated the inmates are not completely isolated. Some of them go out on leave occasionally, but only one of these persons, a man who was sent out into the town with wood, was attacked. Then, again, the children go out to school at the Board School in the village of Linthorpe, and (most important of all) cases of pneumonia from all parts of the union were admitted for treatment in the workhouse infirmary. Opportunities, then, for the introduction of the disease into the buildings were abundant. That it spread as it did through the buildings may again be accounted for by the fact of its communicability in one and another way. The question is, What was the way?

First.—As respects the *child inmates* (all under 16 years of age) who occupy the "school" buildings, which are separate altogether from the buildings occupied by the adults, the following was the sequence of cases:—

Date of Attack.	Sex.	Age.	—
1887.		Years.	
December 8 -	F.	9	(During the whole of 1887 there had been but 2 cases of pneumonia in the school before this, viz., 1 boy aged 10 on September 8, and 1 girl aged 3 on October 21.)
„ 22 -	F.	4	
1888.			
February 15 -	F.	6	
„ 21 -	F.	4	
„ 25 -	M.	8	
„ 27 -	F.	3	
March 2 -	M.	4	All within eight days. Table XIII. shows that a similar burst of pneumonia occurred in June 1883 also in the course of eight days, and when there were no other cases among the inmates of the workhouse, although two cases had recently been admitted into the male infirmary from the outside. A like burst among the children, but affecting both sexes (most the girls), occurred in July 1885 when there were no other cases elsewhere among the inmates.
„ „ -	M.	6	
„ 3 -	M.	5	
„ 7 -	M.	7	
„ 8 -	M.	11	

Date of Attack.	Sex.	Age.	——
[March 14 -	M.	15	Case admitted from outside.]
April 5 - -	F.	13	
[„ 19 - -	F.	4	Case admitted from outside.]
„ 20 - -	F.	14	
May 17 - -	F.	9	
June 1 - -	M.	11	
„ 3 - -	F.	9	
„ 16 - -	F.	6	
„ 28 - -	F.	7	
„ 29 - -	M.	5	
July 22 - -	F.	7	
„ 23 - -	F.	6	
November 2 -	M.	2	
„ 11	M.	8	

This grouping of the sexes is remarkable and suggestive. The male and the female sides of the school did not suffer from the epidemic synchronously. First, the girls were attacked, then for more than a month they were free, during which month there occurred a batch of cases among the boys; then there was a month's lull, after which the girls were attacked again, 8 cases occurring among them between April 5 and July 23, during which time only 2 cases occurred among the boys. This curious grouping of cases and the fact of something of the sort having occurred before seems to show that there were some cause operating in the children's quarters in 1888 which had operated before at a time when the disease was not generally epidemic; probably, therefore, something strictly local, something such as the state of the drainage (p. 244) which had existed from the time that the buildings were erected. No more was seen of pneumonia until November when 2 boys, but no girls, were attacked.

It was suggested to me that the greater incidence of the epidemic upon the children than upon the adults (p. 245) might have been due to their taking cold after their weekly bathing, the season being colder than usual, and children being habitually careless in this respect. Even if this were so, it would not account for all the facts above mentioned; but nevertheless I thought it well to ascertain whether such carelessness and cold-taking at bath-time had any causative relation to the attacks. I found on inquiry that Friday was the bath-day both for boys and girls, and hence if this relation existed, it might have been expected that the cases would in most instances have commenced near about the same day of the week, both with the boys and the girls. But it was not so, as is shown by the following figures:—

Of the 23 cases of inmates mentioned above, the illness commenced—

Cases.

——	Boys.	Girls.	Both Sexes.
On a Sunday - - - -	1	3	4
„ Monday - - - -	—	2	2
„ Tuesday - - -	—	1	1
„ Wednesday - -	1	1	2
„ Thursday - - -	1	5	6
„ Friday - - - -	5	—	5
„ Saturday - - -	2	1	3

Looking now at the ordinary modes of spread of communicable diseases with reference to their ability to account for the facts and figures in

question, it may be stated: (*a.*) As respects food, that for the children, food was prepared in the same kitchen as that of the adults and similarly stored, and that it was similar to that of the adults, except that children under 9 years of age got a half pint of milk daily, which was not supplied to older children and adults. If the food were concerned, the boys and girls attacks would have been expected to have been synchronous, and we should not have expected a larger per-centage of attacks among the children than among the adults, unless indeed infected milk had been a means of spreading the disease. The use of pork or bacon is quite out of the question, since, as a rule, they never had any. (*b.*) The water used for drinking was the same throughout the establishment, and the same as in the towns and in infected and uninfected districts alike. And I have shown before, p. 236, that it was not outside the workhouse an agent for conveying the disease. (*c.*) The grouping of the cases in the two sides of the school might suggest spread by direct personal infection from the sick to the healthy, were it not that as soon as a child was taken ill he was removed to the infirmary ward, and personal infection from child to child could only be believed in on the assumption that the disease is thus communicable at its very earliest stage, the stage of rigors and commencing fever. I cannot say that this is not so, but the table on p. 252 furnishes no evidence of it. (*d.*) The spread by attachment of infective material, issuing from the sick, to the walls, &c. of the building is excluded from acceptance on the same ground, and also because it would not account for the curious gaps in the sequence of cases on the male and female sides respectively. (*e.*) The influence of a contagium carried through the air from a distance, *e.g.*, from cases in the adult wards across a considerable open space to the schools, is also negatived by the attacks on the two sides of the schools not being synchronous, as in that case they might have been expected to be. (*f.*) and (*g.*) The only other thing common to adults and children alike is the system of sewers. Defects in these would appear to be capable of explaining the spread, when once introduced, of the disease among the inmates in the workhouse, its extension to the schools, and the peculiarities of its spread in them. It will suffice here to say that as respects the sewerage and drainage arrangements, nothing could well have been more discreditable to those concerned in laying out and making them, and that, of all parts of the establishment, the most flagrant faults were discovered at the schools (see p. 244).

The alternation in 1888 of incidence on the boys and girls was nothing new in the medical history of the schools. It was a repetition on a larger scale of what might have been observed in former years, as is shown by the following figures, which exhibit the number of cases of pneumonia which occurred in the schools and among adults each year from 1880 onwards:—

Cases.

	Boys.		Girls.		Adults.			
					M.		F.	
1880	3	15	1	4	3	8	—	—
1881	1		1		1		—	
1882	4		1		2		—	
1883	7		1		2		—	
1884	—	9	2	13	1	13	—	2
1885	5		6		1		—	
1886	3		2		5		2	
1887	1		3		6		—	
1888	9		12		13		5	

Up to 1883 (the workhouse was opened for occupation in December 1878) the boys suffered very disproportionately to the girls, but from 1884 the incidence on the two sexes was reversed, and the epidemic of 1888 commenced with the girls. During the whole eight years together, too, the children had suffered much more than adults (assuming, as was probably the case, that the proportion of children to adults in the workhouse population was similar to what it was in 1888).

The disproportion was greatest during the four earlier of the eight years, lessened during the later four years, and was less still during the epidemic year 1888.

Thus the pneumonia attacks were :—

——	Children.	Adults.
1880–3 - -	19 } 41	8 } 23
1884–7 - -	22 }	15 }
1888 - - -	21	18

Secondly.—As to the *adult inmates.* The sequence of adult cases during the last months of 1887 and during 1888 was as follows :—

Date of Attack.	Sex.	Age.	——
1887.			
November 22 -	M.	39	(The only cases among the adult inmates during 1887 prior to this case were—
December 31 -	M.	71	A man aged 74 on April 28
1888.			„ „ 71 „ 30
January 27 -	M.	16	„ „ 64 on May 20
„ 28 -	F.	35	„ „ 29 on July 27
February 8 -	M.	35	The last female inmate attacked prior to the epidemic was on April 22, 1886.)
„ 22 -	F.	44	
„ 23 -	M.	60	
„ 26 -	M.	65	
„ 27 -	M.	66	
March 29 -	F.	40 to 50	
May 17 - -	M.	66	
„ 28 - -	M.	57	
June 2 - -	M.	56	
„ 5 - -	M.	72	
„ 13 - -	M.	72	
„ 14 - -	M.	65	
July 1 - -	M.	71	
„ 9 - -	F.	29	
„ 17 - -	F.	36	
December 10 -	M.	53	This man was a pauper assistant to the female nurse in the pneumonia ward.

Comparing this sequence with that of the children's cases (p. 252) it becomes clear—

(1.) That the 1888 *epidemic* outburst among the inmates began among the adult inmates.

(2.) That the epidemic ended about the same time (the end of July) both among the adults and among the children.

(3.) That the largest number of cases was observed to be synchronous among the adults and the children in the month of February and during June and July, but that the remark does not apply to the male children, for that—

(4.) The eight days' outbreak among the boys occurred at a time in the beginning of March when the disease was practically in abeyance through all the other parts of the workhouse. It was an interpolation, so to speak.

Proportionally to their number, the attacks in 1888 upon the women were half as numerous as among the men; whereas outside the workhouse (Table IX., p. 273) the attacks were on only 106 women to 369 men,—that is to say, if the proportion of women to men in the population remained the same as at the census of 1881 (see p. 189), the attacks elsewhere upon the females were only about one-third as numerous as upon the men. It is to be observed, moreover, as respects the *women*, that up to this epidemic they had been remarkably exempt, and that only two cases had occurred among them in the eight years 1880 to 1887, as seen by the tables just given and Table XIII., p. 289.

These facts indicate: (1) that there was in 1888 some *common cause* operating *throughout* the workhouse during what I have termed the "epidemic period"; (2) that this cause was effective first among the adults and later among the children who reside in the schools quite apart from the adults; and (3) that there must have been some *temporary* cause for the special outbreak among the boys in the month of March.

The question is, what was this common cause at the workhouse which could operate in this way, and which could extend its operation to the women and children as well as the men? What had they all in common? What that was likely to be tainted with the specific contagium of the malady?

It could not have been direct indiscriminate personal communication between the sick persons admitted from outside for treatment, for these sick persons were at once taken into the infirmary, and did not mingle with the healthy persons in the main buildings, but only with those sick from other causes in the infirmary wards. And after the month of July the adult inmates, as well as the new admissions suffering from pneumonia, were placed in a special ward devoted to their reception.

The only circumstances they had all in common likely to be tainted with the *materiæ contagii* were the common atmosphere, the food which was stored, prepared, and distributed from the same part of the main building; the water supply conducted from the main water pipe,—entering the premises from the company's main and distributed by branch pipes to the several buildings; and lastly, the sewers from which drain branches are laid to the several buildings,—with which branches the down-cast rain pipes, the soil pipes of waterclosets, and the sink pipes at the several floors of the buildings, and the drains from the airing grounds, urinals, and washhouses are connected or supposed to be connected. Given the condition of the drainage arrangements and their defects described at p. , the contagium may have spread through the buildings in one or another way as follows:—By means of an atmosphere tainted, previously to its admission to the buildings, by emanations from sewers and drains; or by means of the atmosphere within the buildings having been directly tainted owing to faulty connexion with them of domestic drains. Again, the contagium may have been spread by food similarly tainted by drain or sewer air; or by water, if there were defects in the mains permitting the taking up by them of fluid or air

in soil that had been fouled by leakage from ill-constructed sewers and drains. It is unnecessary to be very precise in apportioning mischief among these subsidiary agencies,—general atmosphere, food, or water, since, at the bottom of any specific taint that these might have been the means of conveying, lie the defects of drainage that would alone have been sufficient to account for taint of one and another of them. As to any pollution of the drinking water nothing definite can be said, since no investigation of the condition of the pipes conveying it was made; but it may be fairly presumed that as much or as little pains were taken to make their joints perfect so as to prevent leakage as was taken with the other conduits for fluids (p. 243). As respects the food the opportunities for its specific pollution were abundant. But I can see no distinct evidence of pork or bacon having been a special agent in the spread of the disease through the house. The children never got any; but it was on two days a week distributed at dinner (pickled pork more than bacon) to such of the adults who liked to have it, except to those in the infirmary wards. And indeed a good deal more was consumed (especially of pickled pork) during the first half of 1888 than during the latter half of 1887. The last day pork was distributed in this half of the year was May 26 and the last bacon day was June 9. but cases occurred among the adult inmates after this date and up to July 17, while only three cases occurred during the three months following February 27, although pork or bacon was distributed from time to time.

The quantities of pork and bacon used each quarter from Midsummer 1887 to Midsummer 1888 were as follow:—

	No. of Weeks on which Pork or Bacon was distributed.	Quantities consumed.		No. of Adult Cases of Pneumonia. (Inmates.)
		Pork.	Bacon.	
1887 Michaelmas quarter -	4	307 lbs.	102	
„ Christmas - -	8	639 „	77	
1888 Lady-day - -	12	1,014 „	3½	8.
„ Midsummer - -	8	1,108 „	191	5 up to June 9.

Neither does the day of the week when the cases commenced furnish any indication that pork or bacon eating was specially concerned in the pneumonia. Mondays and Fridays are the only days on which these articles of food are distributed, and the days of commencing sickness of the 14 cases on the list p. 274 up to June 9 were:—

	Cases.
On Sunday - - -	1
„ Monday - - -	2
„ Tuesday - -	2
„ Wednesday - - -	2
„ Thursday - - -	3
„ Friday - - -	1
„ Saturday - -	3

It must be stated here, lest there should be any improper inference drawn, that this pork and bacon was fed, salted, and dried on the premises. None of either is purchased from outside sources at any time.

These considerations, however, bring us to the conditions of the sewers and drainage arrangements as the agency, and probably the *direct* agency, through which the disease was spread through the various parts of the establishment. Assuming that all that was requisite to cause a spreading outbreak among the inmates was a specific pollution of the contents of these conduits, this pollution the conduits could not have failed to have received from the sputa (and perhaps other excreta) of the pneumonia cases introduced into the infirmary from outside, and subsequently of the cases of inmates treated in the same building. That the earliest cases should have been adults, and that the extension of the disease to the children should have occurred later is no more than might have been looked for, considering the closer relation of the infirmary drainage with that of the buildings occupied by adults than with those occupied by the children.

The admission of cases of pneumonia from outside during the last quarter of 1887 were as follows :—

——	Sex.	Age.
October 4 -	F.	28
November 9 -	M.	39
„ 18 -	M.	31
December 22 -	F.	19
„ 24 -	M.	38
„ 28 -	M.	37

The dates of subsequent admissions, namely, those during 1888, may be seen by consulting Table X., p. 274.

If it be that the *main agency* in the spread of the disease in the workhouse was the sewers and drains, an explanation may probably be found for the remarkable lessening of the epidemic among the inmates during the months of April and May (at a time when no such remarkable *lessening* was indicated by the mortality outside the workhouse) after the rain flushing that the drains and sewers must have had in March and April. The lessening of the rainfall subsequently was followed by the increase of the cases. The following table shows this :—

Four-weekly Period ending	Deaths in Infected Districts.	Cases among Workhouse Inmates.			Rain, in Inches.	Number of Rainy Days.
		Adults.	Children.	Total.		
February 25 -	35	3	3	6	1·09	6
March 24 - -	57	2	6	8	1·28	12
April 21 - -	51	1	2	3	2·25	10
May 19 -	65	1	1	2	1·66	9
June 16 -	106	5	3	8	1·48	9
July 14 - -	55	2	2	4	1·44	13

All that the rain appears to have effected in respect of the pneumonia outside was to hinder and retard its extension; it did not manifestly *lessen* the cases. This seems to indicate further that other additional causes which rainfall does not affect were operative outside, but were not operative at the workhouse.

Some observations made for me at about the same time indicate that there was a distinct and remarkable difference in temperature between the contents of the sewers in the town of Middlesbrough and the contents of the main drain of the workhouse buildings, which may possibly be significant. The difference is such as may permit the belief that a specific micro-organism which was the *vera causa* of the disease had a greater chance of ready propagation in and of diffusion from the latter than in and from the former. The following is the record of Mr. E. D. Latham, the borough engineer, as respects the town sewers :—

Date.	Air. (Fahr.)	Sewage. (Fahr.)	Sediment. (Fahr.)	Water. (Fahr.)
	°	°	°	°
Thursday, July 19 - -	56	54	56	56
Friday „ 20 - -	55	54	55	56
Saturday „ 21 - -	62	56	58	58
Sunday „ 22 - -	62	56	58	58
Monday „ 23 - -	58	56	56	55
Tuesday „ 24 - -	59	56	59	58
Wednesday „ 25 - -	57	56	58	58
Thursday „ 26 - -	58	56	57	58
Friday „ 27 - -	59	57	58	58
Saturday „ 28 - -	58	56	56	58

The following observations at the workhouse were taken on July 20th, by Dr. Malcomson :—

——	Air of Drain. (Fahr.)	Liquid Sewage. (Fahr.)	Deposit. (Fahr.)
	°	°	°
At the northernmost man-hole of the main drain - - - -	70	64	No deposit.
Middle - - - -	70	70	No deposit.
Southernmost (that which finally receives all the sewage of the buildings) - - - -	72	70	72

July 20th was a day on which no washing was proceeding at the workhouse laundry. On days when washing is going on hot water would

be flowing from the laundry into the drains, and the temperature would necessarily be much higher. As it was, the heated air from the middle man-hole and drain below it (which receives the laundry and infirmary sewage) was diffused certainly as far up the drain as that part which receives the drainage from the northernmost (children's) blocks.

Taking all the facts above stated together, it is difficult to resist the inference that, not only were the scandalous faults and condition of the drainage of the workhouse a cause of the spread of the malady through the buildings, and of the very high fatality of the cases treated there, but were the *main* cause of it; and that probably while similar conditions operated to some extent in the town and other parts of the infected district, their agency in spreading the disease was less direct than it was in the workhouse.

I cannot conclude the report without expressing the obligation of the Department for the facilities and lavish assistance afforded me in the present investigation. The Town Council of Middlesbrough, as well as the Local Boards of Ormesby, Normanby, and Eston; the Medical Officers of Health and Surveyors of these bodies, and the Board of Guardians of the Middlesbrough Union, and their several officers:—all have seemed to vie, each with the other, in their endeavours to promote to the utmost the investigation entrusted to me. To the members of my own profession practising in these districts my thanks are peculiarly due for cordial co-operation in every direction. At the risk of seeming invidious to others, I feel bound to make particular mention of Dr. Hinshelwood, the resident medical officer of the North Riding Infirmary, with gratitude for the opportunities of pathological examinations which he obtained for me; and Dr. Malcomson, the Medical Officer of Health of Middlesbrough, for his day-by-day labours in aid of my search after local etiological conditions.

TABLE Ia.

SHOWING the WEEKLY DEATHS from PNEUMONIA under 15 YEARS of AGE in MIDDLESBROUGH, and in the THREE LOCAL BOARD DISTRICTS of ORMESBY, NORMANBY, and ESTON, separately and conjointly, each YEAR from 1880 to 1888.

Weeks.	MIDDLESBROUGH.										ORMESBY.									NORMANBY.									ESTON.								
	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.
1	1	—	—	—	—	3	2	—	6	0·75	1	—	1	—	—	—	2	1	—	4	—	—	1	—	—	—	1	—	—	—	—	—	—	3	—	—	—	—	—
2	—	—	1	—	—	2	2	2	7	0·9	1	—	1	—	—	—	4	—	—	5	—	1	1	—	—	1	—	—	3	—	—	—	—	—	3	—	—	—	—
3	1	—	—	2	—	—	—	—	3	0·4	—	—	—	—	—	—	5	—	—	5	1	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	2	—
4	—	1	2	—	—	—	2	—	5	0·6	1	1	—	—	1	—	—	—	—	2	—	—	—	—	1	—	—	—	1	—	—	1	—	—	3	1	—	5	—
5	3	3	—	—	—	1	—	1	8	1·0	—	—	1	—	—	—	2	—	—	3	—	1	—	—	—	—	—	—	1	—	—	—	—	—	1	1	—	2	—
6	—	1	1	1	—	1	—	1	5	0·6	1	1	1	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	2	—
7	—	—	2	2	—	1	2	1	8	1·0	1	1	1	—	—	—	1	—	—	3	—	—	—	—	1	—	—	—	1	—	—	—	—	1	—	—	—	1	—
8	2	—	3	—	—	—	1	1	7	0·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	2	—	1	—	—	—	1	—	—	1	—
9	—	—	—	—	—	1	1	—	2	·25	—	—	—	—	—	—	—	1	—	1	1	1	—	—	—	—	1	—	3	—	—	—	—	—	—	1	—	—	—
10	—	1	2	—	—	2	3	2	10	1·25	1	—	1	—	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—
11	1	1	2	—	—	—	1	3	8	1·0	2	—	1	—	—	—	—	—	1	2	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—
12	1	1	—	1	—	1	—	3	7	0·9	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	2	—	—	3	—	—	—	—	—	—	—	—	—	—
13	1	—	2	—	—	1	1	2	7	0·9	—	1	—	—	—	—	1	—	—	2	—	1	—	—	—	1	—	—	2	—	—	—	—	—	—	—	—	—	—
14	—	—	1	—	1	1	—	—	3	0·4	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
15	—	—	—	—	—	1	—	3	4	0·5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	2	—	—	—	—	—	—	—	—	—	—
16	—	1	—	—	—	1	2	2	6	0·75	—	—	—	—	—	—	2	—	—	2	—	1	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
17	—	1	1	—	—	—	—	1	3	0·4	2	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—
18	—	—	—	—	—	—	3	—	3	0·4	—	—	—	—	—	—	1	—	—	1	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
19	1	—	—	—	—	1	2	—	4	0·5	—	—	—	—	—	1	—	1	—	2	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
20	2	—	2	—	1	1	—	—	6	0·75	1	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
21	2	1	1	—	—	3	—	6	13	1·6	3	—	—	—	—	—	—	—	—	—	—	1	—	—	—	2	—	—	4	—	—	—	—	—	—	—	—	—	—
22	—	—	1	—	—	—	—	—	1	0·1	4	1	—	—	—	—	—	—	—	1	—	—	1	—	—	1	—	—	2	—	—	—	—	—	—	—	—	—	—
23	—	—	2	1	—	—	2	2	7	0·9	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	1	1	2	—	—	—	—	—	—	—	—	—	—
24	—	—	3	—	—	1	1	1	6	0·75	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	1	2	2	—	1	—	—	—	—	—	—	—
25	—	—	1	—	1	—	1	1	4	0·5	1	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	1	1	2	—	—	—	—	—	1	1	—	2	—
26	—	—	3	—	—	—	6	1	10	1·25	1	—	1	—	—	—	—	—	—	1	—	1	—	1	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—
27	1	1	1	—	1	—	—	—	4	0·5	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
28	1	—	2	1	1	—	—	—	5	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
29	1	1	—	1	1	—	1	1	6	0·75	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	2	—
30	2	—	1	2	—	1	—	1	7	0·9	1	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	2	—
31	—	—	1	—	1	1	—	2	5	0·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
32	1	1	2	—	1	—	1	—	6	0·75	2	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—
33	—	—	2	1	—	—	—	—	3	0·4	3	—	—	—	—	1	—	—	—	1	—	—	—	1	—	—	1	—	2	—	—	—	—	—	—	—	—	—	—
34	2	—	—	3	1	—	—	—	6	0·75	1	—	—	1	—	—	—	—	—	1	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—	—	—	—	—
35	—	—	—	2	—	—	—	—	2	0·25	—	—	—	1	—	—	—	2	—	3	—	—	2	—	—	1	—	1	3	—	—	2	—	—	—	1	—	—	1	—
36	3	—	1	1	—	—	2	—	7	0·9	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—
37	—	—	—	1	—	—	1	—	2	0·25	1	—	—	1	—	—	—	1	—	2	—	—	—	—	—	—	—	—	—	1	—	—	2	—	—	—	1	—	3	—
38	1	—	—	—	1	—	1	—	3	0·4	—	1	—	—	—	—	—	—	1	2	1	—	—	—	—	—	—	1	2	1	—	—	—	—	—	—	—	1	—
39	3	—	—	1	—	—	2	—	6	0·75	—	1	—	—	—	—	—	—	1	2	2	—	1	1	—	—	—	2	4	2	—	—	—	—	1	—	—	3	—
40	—	—	—	—	—	—	—	1	1	0·1	1	1	—	—	—	—	—	—	—	1	2	—	—	1	—	—	2	1	5	1	—	1	—	—	2	2	—	7	—
41	1	1	1	2	2	—	—	1	8	1·0	1	2	—	—	1	—	—	—	—	4	1	1	2	—	—	—	—	—	4	3	1	2	1	—	—	—	1	8	—
42	1	—	—	—	2	—	—	1	4	0·5	—	—	—	—	—	—	—	—	1	1	2	—	1	1	—	—	—	—	4	1	—	—	—	—	—	—	—	1	—
43	1	—	2	—	—	2	—	—	5	0·6	3	—	—	—	—	—	—	—	—	—	1	—	2	—	—	—	—	—	3	1	—	2	—	—	—	—	1	6	—
44	—	—	—	2	1	—	—	1	4	0·7	2	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	1	3	5	—	—	—	—	—	—	—	1	8	—
45	1	1	1	—	3	1	—	1	8	1·0	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	—	1	—	—	—	—	—	3	—
46	1	—	2	1	1	3	1	3	12	1·5	2	1	—	—	—	2	—	—	2	5	—	1	—	1	—	—	1	—	3	3	—	2	—	—	1	—	—	6	—
47	1	—	1	—	—	—	—	—	2	0·25	1	—	—	—	—	1	—	—	—	1	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
48	2	—	1	1	—	2	1	—	7	0·9	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
49	1	—	1	4	1	1	2	1	11	1·4	2	—	—	—	—	—	—	—	1	1	—	—	—	1	3	—	—	2	6	—	—	—	1	3	—	—	3	7	—
50	—	—	5	—	3	—	2	—	10	1·25	1	—	—	—	—	1	—	—	—	1	—	—	—	—	2	3	—	—	1	—	—	—	—	3	—	—	—	1	—
51	1	1	2	—	4	—	2	—	10	1·25	2	—	—	—	1	—	—	—	—	1	—	—	—	—	3	—	—	—	3	—	—	—	1	—	3	—	—	4	—
52, 53	1	—	—	—	3	—	—	—	4	0·5	—	—	—	—	2	—	1	—	—	5	—	—	1	—	2	—	1	—	4	2	—	1	2	6	1	2	1	15	1·9
—	41	17	56	30	30	31	47	49	301	37·6	49	10	8	4	3	8	19	4	13	69	13	12	15	11	6	11	6	11	85	16	—	10	7	16	24	21	14	108

Weeks.	TOTAL OF THE THREE LOCAL BOARD DISTRICTS.													WHOLE INFECTED AREA.										
	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888. O.	1888. N.	1888. E.	1888. Total.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888.
1	—	1	1	—	—	5	1	—	8	1·0	1	—	4	5	1	1	1	—	—	8	3	—	14	1·75	6
2	—	1	1	—	—	6	—	—	9	1·1	—	—	2	2	—	2	2	—	—	8	2	2	16	2·0	3
3	1	—	—	—	—	2	5	—	8	1·0	—	—	2	2	2	—	—	2	2	5	—	—	11	1·4	2
4	—	1	1	1	1	3	1	—	8	1·0	—	—	1	1	1	1	3	1	1	3	3	—	13	1·6	2
5	—	1	—	—	—	3	1	—	6	0·75	—	1	—	1	3	5	—	—	—	4	1	1	14	1·75	1
6	1	1	—	—	—	4	1	—	6	0·5	—	1	2	3	1	2	1	1	—	3	—	1	9	1·1	4
7	—	—	—	—	—	4	—	—	4	0·5	—	1	2	3	1	1	2	2	1	2	3	1	13	1·6	1
8	—	—	—	—	1	1	1	—	3	0·6	—	—	—	—	2	1	3	—	—	2	3	2	13	1·6	2
9	—	—	—	—	—	1	—	—	1	0·6	—	1	1	2	1	1	—	—	—	1	4	—	7	0·9	2
10	1	—	—	—	—	1	—	—	2	0·4	—	—	—	—	—	2	2	—	—	3	4	2	13	1·6	1
11	—	—	—	—	—	1	—	—	1	0·25	—	—	1	1	1	2	2	—	—	—	1	4	10	1·25	3
12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	3	—	3	11	1·4	1
13	1	—	—	—	—	2	—	—	3	0·5	—	—	—	—	2	1	2	—	—	3	1	2	11	1·4	—
14	—	—	—	—	—	2	—	—	2	0·5	—	—	—	—	—	1	1	—	—	2	3	—	7	0·9	—
15	—	—	—	—	—	2	1	—	3	0·25	—	—	1	1	—	—	—	—	—	1	1	4	6	0·75	2
16	—	—	—	—	—	2	3	—	5	0·75	—	—	1	1	—	2	—	—	—	3	5	2	12	1·5	1
17	—	1	—	—	—	1	—	—	2	0·4	—	—	2	2	—	1	2	—	1	—	1	1	6	0·75	4
18	—	—	—	—	—	1	—	—	1	0·4	—	—	—	—	—	1	—	—	1	2	3	6	0·75	—
19	—	—	—	—	1	1	—	—	2	0·4	—	—	—	—	1	—	—	—	—	2	3	6	0·75	—
20	—	—	—	—	—	1	—	—	1	0·25	—	—	—	—	1	—	—	—	—	1	2	6	0·75	—
21	—	1	—	—	—	2	—	1	4	0·5	—	—	—	—	2	2	1	—	—	5	—	7	17	2·1	3
22	—	—	—	—	—	1	—	—	1	0·25	—	—	—	—	1	—	2	—	—	1	3	6	0·75	4
23	—	—	—	—	—	1	—	1	2	0·4	—	1	—	1	—	2	1	1	—	2	4	10	1·25	1
24	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	—	4	—	—	1	2	10	1·25	1
25	—	—	—	—	—	1	—	—	1	0·5	—	—	—	—	—	—	1	—	—	1	2	5	0·6	—	—
26	—	—	—	—	—	1	—	—	1	0·5	—	—	—	—	—	1	1	—	1	2	3	9	1·1	1	—
27	—	—	—	—	—	1	—	—	1	0·5	—	—	—	—	—	2	3	1	—	7	1	14	1·75	1	—
28	—	—	—	—	—	1	—	—	1	0·5	—	—	1	1	1	1	1	1	2	—	1	2	9	1·1	1	—
29	—	—	—	—	—	1	—	—	1	0·1	—	—	—	—	1	1	2	1	1	1	1	2	9	1·1	1	—
30	—	—	—	—	—	1	—	—	1	0·1	—	—	—	—	2	—	1	3	—	1	2	10	1·25	1	—
31	—	—	—	—	—	1	—	—	1	0·1	—	—	—	—	—	—	1	—	—	—	3	6	0·75	—	—
32	—	—	—	—	—	1	—	—	1	0·1	—	—	—	—	1	1	2	—	2	—	1	7	0·9	2	—
33	—	—	—	—	—	1	—	—	1	0·5	—	—	—	—	—	—	2	2	1	—	—	7	0·9	3	—
34	—	—	—	—	—	1	—	—	1	0·75	—	1	—	1	2	—	2	3	2	—	1	2	12	1·5	2	—
35	—	—	—	—	—	1	—	—	1	0·6	—	—	—	—	—	—	4	—	—	1	2	7	0·9	—	—
36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	1	1	—	—	3	—	8	1·0	—	—
37	1	—	—	—	—	1	—	—	2	0·6	—	—	—	—	1	—	1	3	—	1	—	—	7	0·9	1	—
38	1	—	—	—	—	1	—	—	2	0·6	—	—	1	1	4	—	1	2	—	1	1	3	10	1·25	1	—
39	4	—	—	—	—	1	—	—	5	0·9	—	—	—	—	7	—	1	1	—	2	2	—	14	1·75	—	—
40	2	—	—	—	—	1	—	—	3	0·9	—	—	—	—	2	—	1	—	—	2	3	8	1·0	1	—	—
41	1	—	—	—	—	1	—	—	2	0·6	—	—	—	—	1	—	3	2	2	—	—	2	16	2·0	1	—
42	1	—	—	—	—	1	—	—	2	0·6	—	—	—	—	4	2	3	3	2	—	—	2	16	2·0	1	—
43	1	—	—	—	—	1	—	—	2	0·9	—	—	1	1	4	—	1	2	—	—	2	10	1·25	—	—	—
44	—	—	—	—	—	1	—	—	1	0·9	—	—	1	1	3	—	4	—	—	—	3	1	11	1·5	4	—
45	1	—	—	—	—	1	—	—	1	0·4	—	—	—	—	5	—	1	3	1	—	—	2	12	1·5	2	—
46	1	—	—	—	—	1	—	—	1	0·4	—	—	1	1	2	1	2	1	1	1	1	1	12	1·5	3	—
47	1	—	—	—	—	1	—	—	1	0·4	—	—	—	—	5	1	4	2	3	3	2	6	26	3·25	2	—
48	2	—	—	—	—	1	—	—	1	0·4	—	—	1	1	1	—	2	2	1	—	1	—	7	0·9	2	—
49	1	—	—	—	—	1	—	—	1	0·4	—	—	1	1	2	—	1	1	—	2	—	4	11	1·4	2	—
50	—	—	—	—	—	1	—	—	1	0·4	—	—	—	—	1	—	1	3	2	2	4	18	2·25	3	—	—
51	1	—	—	—	—	1	—	—	1	0·4	—	—	—	—	—	—	5	1	6	3	2	2	19	2·4	2	—
52, 53	1	—	—	—	—	1	—	—	1	0·4	—	—	—	—	1	1	3	—	7	—	2	—	14	1·75	2	—
—	39	20	29	21	30	54	31	38	262	32·9	1	11	21	33	80	37	85	51	60	85	78	87	563	70·5	82

Table 16.

Showing the Weekly Deaths from Pneumonia from 15 Years of Age and upwards in Middlesbrough, and in the Three Local Board Districts of Ormesby, Normanby, and Eston, separately and conjointly, each Year from 1880 to 1888.

Weeks.	Middlesbrough.										Ormesby.									Normanby.									Eston.								
	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.
1	1	—	3	1	—	2	—	2	9	1·1	2	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	2	—	—	1	—	—	1	—	—	2
2	2	1	2	1	—	—	1	2	9	1·1	3	2	—	—	—	—	—	1	—	3	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2
3	—	1	—	1	—	—	—	3	5	0·6	1	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	2	1	1	1	—	—	1	—	—	4
4	3	3	—	4	1	—	3	2	16	2·0	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2
5	2	4	1	3	1	2	6	1	20	2·5	4	—	—	—	1	—	—	—	—	1	—	1	—	—	—	—	—	—	1	—	—	—	3	—	—	—	—	3
6	3	1	2	1	—	1	2	—	10	1·25	4	—	—	—	—	—	—	—	1	1	—	—	—	—	1	—	—	—	1	1	1	—	—	—	—	1	—	3
7	—	2	1	2	3	—	—	1	9	1·1	7	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	2	—	—	—	1	—	1	—	—	2
8	1	2	—	2	—	2	—	1	8	1·0	7	1	—	—	1	—	—	1	—	3	—	—	1	—	—	—	—	1	—	1	1	—	1	1	—	—	—	3
9	—	3	—	3	—	2	3	1	12	1·5	13	1	—	—	—	—	—	—	—	1	2	1	—	—	—	—	1	—	3	—	—	—	—	—	1	—	1	3
10	2	2	3	1	1	3	6	2	20	2·5	11	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	1	—	1	—	2	1	—	—	—	—	—	3
11	1	2	2	2	1	1	4	2	15	1·9	11	—	—	—	1	—	—	—	1	2	—	1	2	—	1	1	—	2	5	—	2	—	1	4	1	—	2	10
12	1	—	1	3	4	2	6	3	20	2·5	9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	4	—	—	—	—	1	1	2	5
13	3	1	3	5	1	2	2	1	18	2·25	13	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	1	5	—	—	—	1	—	—	—	1	2
14	—	—	2	2	—	2	—	5	11	1·4	7	—	—	—	2	—	2	—	—	4	1	—	—	4	—	—	—	—	5	—	—	—	1	1	1	1	—	4
15	1	1	1	1	—	2	2	6	14	1·75	10	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	3	1	—	—	—	1	—	—	—	2
16	—	4	3	—	2	2	1	3	15	1·9	10	—	—	—	—	—	—	—	2	2	—	—	—	—	—	1	—	—	1	—	1	—	—	—	—	1	—	1
17	—	1	4	1	—	—	3	2	11	1·4	16	—	—	—	1	—	—	—	—	1	—	—	—	1	—	—	—	—	1	1	—	2	—	—	—	—	—	3
18	—	—	2	2	1	—	—	5	10	1·25	12	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	2	4	—	—	1	—	1	—	—	—	2
19	2	—	3	3	2	3	2	2	17	2·1	8	—	—	—	—	1	—	—	—	1	—	—	—	—	—	1	2	—	3	—	1	1	—	1	—	—	—	2
20	1	1	2	4	2	2	2	2	16	2·0	12	—	—	—	—	—	1	—	—	1	2	—	—	1	—	—	2	1	6	—	—	—	1	2	—	—	—	3
21	1	2	3	3	2	—	3	5	19	2·4	26	—	—	1	—	1	—	—	—	2	—	—	1	—	—	—	—	—	1	—	1	1	—	—	—	—	—	2
22	—	1	1	4	3	4	—	4	17	2·1	22	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	1	—	1	—	—	—	—	—	1	1	1	3
23	—	1	3	1	3	1	2	3	14	1·75	21	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	1	—	1	—	—	1	1	—	—	2	—	4
24	—	2	1	3	4	2	3	3	18	2·25	8	—	—	—	1	—	1	—	1	3	—	—	—	—	—	—	1	—	1	—	—	1	1	—	—	1	—	2
25	—	1	2	6	1	—	3	2	15	1·9	11	—	—	—	1	—	—	—	—	1	1	1	—	—	—	—	1	—	3	1	2	—	2	—	—	1	—	3
26	1	—	3	4	1	4	—	1	14	1·75	10	—	—	1	1	—	—	—	—	2	—	—	1	—	—	1	1	—	3	—	—	2	2	—	2	2	—	8
27	—	1	2	1	—	3	—	2	9	1·1	5	—	—	—	—	—	—	1	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
28	—	2	—	2	1	—	1	1	7	0·9	8	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	—	—	1	—	—	—	—	—	1	1	—	2
29	—	1	—	—	—	3	1	2	7	0·9	4	—	—	—	2	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
30	—	1	1	1	—	—	—	1	4	0·5	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31	1	—	3	—	1	—	—	—	5	0·6	3	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	1	—	—	1
32	—	—	2	2	2	—	—	—	6	0·75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
33	1	1	—	—	—	3	1	1	7	0·9	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
34	2	—	—	—	1	1	—	—	4	0·5	3	—	—	1	—	—	—	1	—	1	—	—	—	—	—	—	—	1	1	—	—	2	—	1	1	—	—	6
35	1	—	3	—	1	2	1	—	8	1·0	2	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	1	—	—	1	—	—	—	—	—	1
36	2	—	—	—	1	1	—	—	4	0·5	2	—	—	—	—	—	1	—	—	1	—	—	1	—	—	—	—	—	1	—	—	1	—	—	1	—	—	3
37	—	1	1	—	—	1	—	—	3	0·4	2	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	2	—	3	—	—	—	—	—	—	1	—	1
38	1	—	—	5	2	1	2	—	11	1·4	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	1
39	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	2	3	3	—	1	—	—	—	—	—	—	1
40	1	—	1	1	—	—	5	1	9	1·1	2	—	—	—	—	—	—	1	—	1	—	1	—	—	—	—	—	—	1	1	1	—	—	—	—	—	—	1
41	—	1	1	—	1	—	2	—	5	0·6	—	—	—	—	—	1	—	—	—	—	1	—	—	1	—	—	1	—	3	1	—	1	1	1	1	1	—	6
42	—	2	1	1	—	3	1	1	9	1·1	2	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	1	1	2	—	—	1	—	—	—	1	1	3
43	1	—	—	2	—	—	—	2	5	0·6	4	—	—	—	—	—	—	1	—	1	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	1	—	1
44	2	2	1	2	—	4	2	—	13	1·6	2	—	—	—	1	—	—	—	—	1	1	1	1	—	1	—	—	1	5	—	—	—	—	—	—	—	—	—
45	—	2	—	2	—	4	2	—	10	1·25	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
46	3	—	3	—	2	1	2	—	11	1·4	4	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	—	—	3	—	—	1	—	—	—	—	—	1
47	3	—	—	1	—	1	—	4	9	1·1	2	—	—	—	1	—	—	—	—	1	—	—	—	1	—	—	—	—	1	1	—	—	—	—	—	—	—	—
48	3	1	3	4	—	2	3	1	17	2·1	2	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	2	3	1	—	1	—	—	—	—	—	2
49	—	1	2	1	—	1	1	1	7	0·9	1	—	—	—	1	—	1	—	—	2	—	—	—	1	—	—	1	—	1	1	—	—	2	1	2	1	—	3
50	1	—	5	—	3	—	6	—	15	1·9	—	1	—	—	1	—	—	—	1	2	1	—	—	—	—	—	1	—	2	1	—	—	—	—	—	1	—	2
51	1	2	1	2	1	3	1	1	12	1·5	1	—	—	—	1	—	—	—	1	2	—	—	—	—	—	—	1	—	2	—	—	2	—	—	1	—	—	3
52, 53	1	1	1	—	3	—	2	6	14	1·75	1	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	—	—	4	—	1	—	2	—	1	2	—	6
—	49	55	79	90	51	73	88	88	573	71·6	320	4	—	8	12	3	6	5	9	47	13	7	9	13	7	7	17	18	91	6	10	22	12	12	13	17	16	108

Weeks.	Total of the Three Local Board Districts.													Whole Infected Area.										
	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888. O.	1888. N.	1888. E.	1888. Total.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888.
1	—	—	1	1	—	1	—	1	4	0·5	1	—	2	3	1	—	4	2	—	3	—	2	13	1·6	5
2	2	—	—	—	1	—	1	—	5	0·6	—	—	—	—	4	1	2	1	1	1	—	3	14	1·75	3
3	1	1	2	—	1	1	—	—	6	0·75	—	—	2	2	1	2	2	1	1	1	—	3	11	1·4	3
4	—	—	—	—	—	—	1	1	2	0·25	—	—	—	—	3	3	—	4	1	—	4	3	18	2·25	2
5	—	1	—	3	—	—	—	—	3	0·6	—	—	—	—	2	5	1	7	1	2	6	1	25	3·1	4
6	1	1	—	—	—	1	—	1	3	0·75	2	—	—	2	4	2	2	1	1	1	3	2	16	2·0	6
7	—	—	—	1	—	1	—	—	2	0·25	—	—	—	—	—	2	1	3	3	1	—	1	11	1·4	7
8	1	—	1	1	—	—	2	—	5	0·6	2	—	1	3	2	2	1	3	—	2	2	1	13	1·6	10
9	—	—	—	—	—	—	1	—	1	0·6	—	2	1	3	3	4	—	3	—	2	4	1	17	2·1	16
10	3	1	—	—	—	—	—	—	4	0·5	1	1	—	2	2	4	4	1	1	3	7	2	24	3·0	13
11	1	—	1	4	1	—	2	1	10	1·25	—	1	—	1	1	2	3	6	2	1	6	4	25	3·1	12
12	—	—	1	3	1	1	1	1	8	1·0	—	—	—	—	1	2	3	5	3	7	5	5	25	3·1	9
13	1	—	1	2	2	—	1	2	7	0·9	—	1	—	1	3	1	4	7	2	2	3	2	25	3·1	14
14	—	—	—	—	1	1	1	—	4	1·6	—	—	1	1	1	—	2	9	1	5	1	5	24	3·0	8
15	1	—	2	1	—	1	—	—	5	0·6	—	2	1	3	3	1	1	1	—	4	2	7	19	2·4	13
16	—	—	—	—	—	—	1	3	4	0·5	—	—	3	3	—	5	3	—	2	2	2	5	19	2·4	13
17	1	—	2	—	—	—	—	—	3	0·6	—	1	2	3	1	1	6	3	—	—	3	2	16	2·0	19
18	1	—	2	1	—	—	—	4	8	1·0	—	2	1	3	1	—	4	2	2	—	—	9	18	2·25	15
19	—	1	1	—	1	1	1	2	7	0·9	2	1	—	3	2	1	4	3	3	4	3	4	24	3·0	11
20	2	—	—	2	2	1	2	1	10	1·25	1	2	—	3	3	1	2	6	4	3	4	3	26	3·25	15
21	—	1	3	—	1	—	—	—	5	0·6	2	3	2	7	1	3	6	3	3	—	3	5	24	3·0	33
22	—	—	—	—	—	—	1	1	2	0·4	—	1	3	4	—	1	1	4	3	5	1	5	20	2·5	26
23	—	—	1	1	—	1	2	1	6	0·75	—	1	3	4	—	1	4	2	3	2	4	4	20	2·5	25
24	—	—	1	1	—	1	—	—	2	0·75	1	4	—	5	—	2	2	4	4	3	5	4	24	3·0	13
25	1	—	1	—	—	—	2	—	4	0·9	1	2	1	4	1	3	2	8	1	—	5	2	22	2·75	15
26	—	—	1	—	—	—	—	—	1	0·25	—	1	2	3	1	—	5	6	1	6	2	1	22	2·75	13
27	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	2	1	1	2	1	1	10	1·25	2
28	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	2	1	8	1·0	5
29	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	—	2	—	3	1	2	9	1·1	5
30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	—	—	1	4	0·5	5
31	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	4	—	1	1	—	1	8	1·0	5
32	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	2	2	2	—	—	—	6	0·75	1
33	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	—	—	—	3	2	1	8	1·0	4
34	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	2	—	1	2	2	1	10	1·25	3
35	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	1	2	1	—	9	1·1	2
36	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	—	1	—	1	2	—	1	7	0·9	2
37	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	1	1	—	—	3	—	—	6	0·75	3
38	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	—	2	1	1	2	1	2	10	1·5	3
39	—	—	—	—	—	—	—	—	—	—	—	1	2	3	—	1	—	—	—	2	—	—	3	0·4	1
40	—	—	—	—	—	—	—	—	—	—	—	—	1	1	2	1	1	—	—	—	6	1	12	1·5	2
41	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1	1	2	1	2	1	3	—	11	1·4	1
42	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	1	—	3	2	2	1	12	1·5	3
43	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	1	2	1	4	9	1	5	1·1	5
44	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3	2	3	1	4	2	2	20	2·5	2
45	—	—	—	—	—	—	—	—	—	—	1	1	—	2	—	2	—	2	—	4	2	—	10	1·25	2
46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	1	5	—	2	1	2	—	15	1·9	4
47	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	1	1	5	14	1·75	2
48	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	1	4	4	—	2	3	3	21	2·6	2
49	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	4	2	2	2	1	1	13	1·6	1
50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	7	—	3	1	7	1	21	2·6	—
51	—	—	—	—	—	—	—	—	—	—	—	1	—	1	1	2	3	2	1	4	4	2	19	2·4	2
52, 53	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	3	2	1	5	—	4	8	24	3·0	1
—	23	17	39	37	22	26	39	43	246	30·7	19	39	30	88	72	72	118	127	73	99	127	131	819	102·4	408

TABLE II.

SHOWING the DEATHS registered as from "PNEUMONIA" during 9 years, 1880-88, in FOUR-WEEKLY PERIODS.

Under 15 years of Age.

Four weekly Periods.	Borough of Middlesbrough.											The Three Local Board Districts.											Entire District.										
	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.	Mean of 8 Years.	1888.
1	2	1	3	2	—	5	6	2	21	2·6	3	2	3	3	1	3	19	2	—	33	4·1	10	4	4	6	3	3	24	8	2	54	6·7	13
2	5	4	6	3	—	3	3	4	28	3·5	2	2	5	—	—	1	8	4	1	21	2·6	6	7	9	6	3	1	11	7	5	49	6·1	8
3	2	3	4	1	—	4	5	8	27	3·4	4	1	3	1	—	1	3	4	1	14	1·7	3	3	6	5	1	1	7	9	9	41	5·1	7
4	1	1	3	—	1	4	3	7	20	2·5	2	1	3	—	—	—	6	4	2	16	2·0	1	2	4	3	—	1	10	7	9	36	4·5	3
5	3	1	3	—	1	2	2	4	16	2·0	3	—	—	2	1	1	4	1	1	10	1·2	2	3	1	5	1	2	6	3	5	26	3·2	5
6	2	1	7	1	—	4	3	9	27	3·4	7	3	1	2	—	1	3	2	4	16	2·0	2	5	2	9	1	1	7	5	13	43	5·4	9
7	2	1	7	1	3	—	7	2	23	2·9	2	—	3	—	2	1	2	3	4	15	1·9	1	2	4	7	3	4	2	10	6	38	4·7	3
8	4	2	4	3	3	2	2	4	24	3·0	3	—	—	1	2	2	—	1	2	8	1·0	1	4	2	5	5	5	2	3	6	32	4·0	4
9	5	—	3	7	1	—	2	—	18	2·2	4	—	—	6	1	2	—	2	5	16	2·0	1	5	—	9	8	3	—	4	5	34	4·2	5
10	4	—	—	2	1	—	4	1	12	1·5	2	10	—	2	4	—	4	2	5	27	3·4	1	14	—	2	6	1	4	6	6	39	4·9	3
11	3	1	3	4	5	—	2	3	21	2·6	6	13	1	6	3	—	—	1	4	28	3·6	1	16	2	9	7	5	—	3	7	49	6·2	7
12	5	1	5	2	4	6	2	4	29	3·6	6	5	1	4	3	3	1	3	3	23	2·9	2	10	2	9	5	7	7	5	7	52	6·5	8
13	3	1	8	4	11	1	6	1	35	4·4	5	2	—	2	4	15	4	2	6	35	4·4	2	5	1	10	8	26	5	8	7	70	8·7	7
—	41	17	56	30	30	31	47	49	301	37·6	49	39	20	29	21	30	54	31	38	262	32·9	33	80	37	85	51	60	85	78	87	563	70·5	82

15 years of Age and upwards.

1	6	5	5	7	1	2	4	9	39	4·9	8	3	1	3	1	2	2	3	2	17	2·1	5	9	6	8	8	3	4	7	11	56	7·0	13
2	6	9	4	8	4	5	8	3	47	5·9	22	2	2	1	6	1	1	3	2	18	2·2	5	8	11	5	14	5	6	11	5	65	8·1	27
3	4	7	6	9	6	8	19	8	67	8·4	44	3	3	2	4	2	1	5	4	24	3·0	6	7	10	8	13	8	9	24	12	91	11·4	50
4	4	6	9	8	3	8	5	15	58	7·2	40	3	1	1	9	2	5	3	5	29	3·6	8	7	7	10	17	5	13	8	20	87	10·9	48
5	3	2	11	10	5	5	7	11	54	6·7	48	4	1	5	4	4	2	3	7	30	3·7	12	7	3	16	14	9	7	10	18	84	10·5	60
6	1	6	8	11	12	7	8	15	68	8·5	77	—	1	5	2	1	3	5	3	20	2·5	20	1	7	13	13	13	10	13	18	88	11·0	97
7	1	4	7	13	3	7	4	6	45	5·6	34	1	2	2	4	2	3	4	2	20	2·5	18	2	6	9	17	5	10	8	8	65	8·1	52
8	1	2	6	3	3	3	1	3	22	2·7	11	—	—	1	2	—	1	—	1	5	0·6	5	1	2	7	5	3	4	1	4	27	3·4	16
9	6	1	3	—	2	7	3	1	23	2·9	11	—	—	4	—	1	2	2	2	11	1·4	—	6	1	7	—	3	9	5	3	34	4·2	11
10	2	1	2	6	2	2	7	1	23	2·9	6	1	2	—	—	1	2	1	3	10	1·2	3	3	3	2	6	3	4	8	4	33	4·1	9
11	3	5	3	5	1	7	5	3	32	4·0	8	2	1	4	2	2	1	3	5	20	2·4	3	5	6	7	7	3	8	8	8	51	6·4	11
12	9	3	6	7	2	8	7	5	47	5·9	8	3	1	4	1	—	—	1	3	13	1·6	2	12	4	10	8	2	8	8	8	60	7·5	10
13	3	4	9	3	7	4	10	8	48	6·0	3	1	2	7	2	4	3	6	4	29	3·6	1	4	6	16	5	11	7	16	12	77	9·6	4
—	49	55	79	90	51	73	88	88	573	71·6	320	23	17	39	37	22	26	39	43	246	30·6	88	72	72	118	127	73	99	127	131	819	102·4	408

Table III.

Showing for the Entire District and each Sanitary District the Pneumonia Mortality in each Sex and in Groups of Ages during each of the 13 Four-Weekly Periods of 1888, together with the principal Meteorological Conditions prevalent in each Period.

Four-Weekly Period ending	All Ages.												The Three Local Board Districts.															Middlesbrough.								Borough and Local Board Districts together, 15 years and upwards only.			Mean Meteorological Conditions (Albert Park, Middlesbrough).				
	Borough of Middlesbrough.			Local Board District, Ormesby.			Local Board District, Normanby.			Local Board District, Eston.			Total in Borough and Local Board Districts together.			Years of Age.													Years of Age.															
																0—			15—			45—			65 upwards.			15 years and upwards only.			0—	15—	45—	65 up.	15 years and upwards only.									
Estimated Population	69,255			8,662			9,069			10,620			97,606			11,651			13,229			2,995			496			16,720			27,893	32,306	7,699	1,357	41,362			58,082							
	M.	F.		M.	F.		M.	F.		M.	F.		M.	F.		O.	N.	E.																									
January 7	9	2	= 11	—	2	= 2	—	—	—	7	6	13	16	10	= 26	1	—	9	Total. = 10	—	—	1	Total. = 1	1	—	—	Total. = 1	—	—	3	Total. = 3	2	3	= 5	3	4	3	1	7	1	= 8	9	4	= 13	38·8°	7·5	0·90	8	N.E., S.W., W.
February 25	18	6	= 24	1	3	= 4	2	1	= 3	3	1	= 4	24	11	= 35	—	3	3	= 6	2	—	1	= 3	—	—	—	= —	2	—	—	= 2	2	3	= 5	2	9	12	1	16	6	= 22	18	9	= 27	38·4	9·3	1·09	6	N.W., N.E.
March 24	40	8	= 48	—	1	= 1	3	2	= 5	2	1	= 3	45	12	= 57	—	1	2	= 3	1	3	1	= 5	—	1	—	= 1	—	—	—	= —	2	4	= 6	4	19	21	4	37	7	= 44	39	11	= 50	32·8	8·0	1·28	12	E., N.E.
April 21	34	8	= 42	—	—	= —	3	—	= 3	3	3	= 6	40	11	= 51	—	—	1	= 1	—	1	2	= 3	—	2	3	= 5	—	—	—	= —	6	2	= 8	2	15	21	4	32	8	= 40	38	10	= 48	38·0	14·4	2·25	10	N.W., N.E., S.W.
May 19	43	8	= 51	1	2	= 3	4	2	= 6	3	2	= 5	51	14	= 65	—	—	2	= 2	1	4	1	= 6	1	2	—	= 3	1	—	2	= 3	7	5	= 12	3	22	21	5	42	6	= 48	49	11	= 60	43·2	16·1	1·66	9	S.W., W.
June 16	66	18	= 84	3	—	= 3	9	2	= 11	6	2	= 8	84	22	= 106	—	2	—	= 2	2	4	4	= 10	1	3	3	= 7	—	2	1	= 3	17	3	= 20	7	34	32	11*	60	17*	= 77	77	20*	= 97	50·4	19·9	1·48	9	Var.
July 14	31	5	= 36	3	1	= 4	8	1	= 9	2	4	= 6	44	11	= 55	—	—	1	= 1	4	3	4	= 11	—	4	1	= 5	—	2	—	= 2	12	6	= 18	2	18	8	8	30	4	= 34	42	10	= 52	51·8	22·0	1·44	13	N.E., Var., S.W.
August 11	11	3	= 14	1	—	= 1	2	1	= 3	2	—	= 2	16	4	= 20	—	—	1	= 1	1	1	—	= 2	—	2	1	= 3	—	—	—	= —	4	1	= 5	3	6	5	—	9	2	= 11	13	3	= 16	53·4	23·2	4·85	20	N.E., S.W.
September 3	8	7	= 15	—	—	= —	—	1	= 1	—	—	= —	8	8	= 16	—	1	—	= 1	—	—	—	= —	—	—	—	= —	—	—	—	= —	—	—	= —	4	4	6	1	7	4	= 11	7	4	= 11	54·8	23·6	1·95	18	S.W.
October 6	5	3	= 8	—	—	= —	—	1	= 1	1	2	= 3	6	6	= 12	—	—	1	= 1	—	1	1	= 2	—	—	—	= —	—	—	1	= 1	1	2	= 3	2	2	4	—	5	1	= 6	6	3	= 9	48·5	23·2	0·84	10	S.W., Var., S.
November 3	11	3	= 14	1	—	= 1	2	1	= 3	—	—	= —	14	4	= 18	—	1	—	= 1	—	2	—	= 2	1	—	—	= 1	—	—	—	= —	2	1	= 3	6	5	3	—	6	2	= 8	8	3	= 11	44·4	19·5	0·59	6	S.W.
December 1	12	2	= 14	1	—	= 1	3	—	= 3	—	—	= —	16	2	= 18	—	2	—	= 2	1	—	—	= 1	—	1	—	= 1	—	—	—	= —	2	—	= 2	6	3	4	1	7	1	= 8	9	1	= 10	41·9	10·6	2·11	14	N.E., E., S.W.
December 29	5	3	= 8	—	—	—	1	1	= 2	1	—	= 1	7	4	= 11	—	1	1	= 2	—	1	—	= 1	—	—	—	= —	—	—	—	= —	1	—	= 1	5	—	3	—	3	—	= 3	4	—	= 4	36·5	11·5	0·65	11	S., SW.
	293	76	= 369	11	9	= 20	37	13	= 50	30	21	= 51	371	119	= 490	1	11	21	= 33 [M. 20; F. 13.]	12	20	50	= 47 [M. 28; F. 19.]	4	15	8	= 27 [M. 21; F. 6.]	3	4	7	= 14 [M. 9; F. 5.]	58	30	= 88	49	141	143	36	261	59	= 320	319	89	= 408					

* Note how drought affected old people and women who are much at home and thus were more exposed than others to drain and other foul emanations about their dwellings.

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Table IV.—*continued.*

Normanby.

——	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.
	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.
Pre-epidemic period	1 —	— 1	2 1	1 —	2 1	1 —	— —	1 —	8 3
Epidemic „	10 1	5 7	4 3	10 1	5 1	7 5	10 6	13 5	64 29
Post-epidemic „	7 7	4 2	7 7	9 3	2 2	3 2	5 2	3 7	40 32
Whole year -	18 8	9 10	13 11	20 4	9 4	11 7	15 8	17 12	112 64
Deaths, both sexes	26	19	24	24	13	18	23	29	176
Males, per cent. of deaths of both sexes -	69·2	47·4	54·2	83·3	69·2	61·1	65·2	58·6	63·6

Eston.

Pre-epidemic period	1 —	1 —	2 1	— —	2 —	7 2	2 1	1 —	16 4
Epidemic „	2 1	7 —	9 3	9 3	6 2	10 7	14 7	5 3	62 26
Post-epidemic „	10 8	1 1	10 7	7 —	8 10	5 6	7 7	12 9	60 48
Whole year -	13 9	9 1	21 11	16 3	16 12	22 15	23 15	18 12	138 78
Deaths, both sexes	22	10	31	19	28	37	38	30	216
Males, per cent. of deaths of both sexes -	59·1	90·0	67·7	84·2	57·1	59·5	60·5	60·0	63·9

Entire District.

Pre-epidemic period		5 5	10 4	11 —	5 1	13 15	8 7	11 2	73 37
Epidemic „	39 15	51 19	59 37	70 27	34 21	63 35	76 39	85 43	477 236
Post-epidemic „	44 41	22 7	56 37	50 20	41 31	33 25	48 27	45 32	339 220
Whole year -	93 59	78 31	125 78	131 47	80 53	109 75	132 73	141 77	889 493
Deaths, both sexes	152	109	203	178	133	184	205	218	1,382
Males, per cent. of deaths of both sexes -	61·2	71·6	61·6	73·6	60·2	59·2	64·4	64·7	64·3

Table V.

Showing, for the Entire District and for each Sanitary District separately, the Number of Deaths from "Pneumonia" occurring in *each Sex* at Ages 15 *years and upwards* in every Year from 1880 to 1887 inclusive, and in the Pre-Epidemic, Epidemic, and Post-Epidemic Period of each Year,* and in the Total of all the Years and of each Period, together with the Per-centage of Male Deaths to Deaths of Both Sexes each Year and in the Aggregate of Years.

Middlesbrough.

——	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.
	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.	M. F.
Pre-epidemic period	5 1	2 3	3 2	7 —	1 —	— 2	4 —	7 2	29 10
Epidemic „	16 3	28 6	33 12	43 16	20 13	31 9	36 15	38 20	245 94
Post-epidemic „	13 11	13 3	18 11	17 7	12 5	22 9	24 9	14 7	133 62
Whole year -	34 15	43 12	54 25	67 23	33 18	53 20	64 24	59 29	407 166
Deaths, both sexes	49	55	79	90	51	73	88	88	573
Males, per cent. of deaths of both sexes -	69·4	78·2	68·4	74·4	64·7	72·6	72·7	67·0	71·0

Ormesby.

Pre-epidemic period	1 1	— —	— —	— —	— —	— —	1 —	— —	2 1
Epidemic „	2 —	— —	1 1	4 5	2 —	4 1	2 —	4 2	19 9
Post-epidemic „	— —	— —	2 4	3 —	— 1	1 —	— 2	2 1	8 8
Whole year -	3 1	— —	3 5	7 5	2 1	5 1	3 2	6 3	29 18
Deaths, both sexes	4	—	8	12	3	6	5	9	47
Males, per cent. of deaths of both sexes -	75·0	—	37·5	58·3	66·6	83·3	60·0	66·6	61·7

* Corresponding to the three adopted periods of the epidemic year 1888.

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TABLE V.—*continued.*

Normanby.

—	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	Total.
Pre-epidemic period	— —	— —	1 —	1 —	1 —	— —	— —	1 —	4 —
Epidemic „	8 —	2 1	2 2	7 1	3 1	2 1	8 4	8 5	40 15
Post-epidemic „	3 2	3 1	1 3	4 —	2 —	3 1	4 1	2 2	22 10
Whole year -	11 2	5 2	4 5	12 1	6 1	5 2	12 5	11 7	66 25
Deaths, both sexes	13	7	6	13	7	7	17	18	91
Males, per cent. of deaths of both sexes -	84·6	71·4	44·4	92·3	85·7	71·4	70·6	61·1	72·5

Eston.

Pre-epidemic period	1 —	1 —	2 —	— —	1 —	2 —	1 1	1 —	9 1
Epidemic „	2 1	7 —	8 2	9 3	4 2	5 2	7 2	3 1	45 13
Post-epidemic „	1 1	1 1	4 6	— —	2 3	2 2	4 2	8 3	22 18
Whole year -	4 2	9 1	14 8	9 3	7 5	9 4	12 5	12 4	76 32
Deaths, both sexes	6	10	22	12	12	13	17	16	108
Males, per cent. of deaths of both sexes -	66·6	90·0	63·6	75·0	58·3	69·2	70·5	75·0	70·4

Entire District.

Pre-epidemic period	7 2	3 3	6 2	8 —	3 —	2 2	6 1	9 2	44 12
Epidemic „	28 4	37 7	44 17	63 25	29 16	42 13	53 21	53 28	349 131
Post-epidemic „	17 14	17 5	25 24	24 7	16 9	28 12	32 14	26 13	185 98
Whole year -	52 20	57 15	75 43	95 32	48 25	72 27	91 36	88 43	578 241
Deaths, both sexes	72	72	118	127	73	99	127	131	819
Males, per cent. of deaths of both sexes -	72·2	79·2	63·6	74·8	65·8	72·7	71·7	67·2	70·6

Table VI.

Showing, for the Entire District and for each Sanitary District separately, the Deaths from "Pneumonia" which occurred in each of the 13 Four-Weekly Periods of 1888, arranged in Age-Groups mostly of 10 years each, and distinguishing the Sexes.

Ages—	0—					1—					5—					15—					25—					35—					45—					55—					65—					Summary—Entire District.				
Four-Weekly Periods.	M.	O.	N.	E.	Entire District.	M.	O.	N.	E.	Entire District.	M.		N.	E.	Entire District.	M.	O.	N.	E.	Entire District.	M.	O.	N.	E.	Entire District.	M.	O.	N.	E.	Entire District.	M.	O.	N.	E.	Entire District.	M.	O.	N.	E.	Entire District.	M.	O	N.	E.	Entire District	0—	15—	45—	65 upwards.	15 upwards.
1 M.	1	—	—	4	= 5	—	—	—	1	= 1	1	—	—	—	= 1	1	—	—	—	= 1	1	—	—	—	= 1	1	—	—	—	= 1	1	—	—	—	= 1	2	—	—	—	= 2	1	—	—	2	= 3	7	3	3	3	9
1 F.	—	—	—	1	= 1	1	—	—	3	= 4	—	1	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	1	—	—	1	= 2	—	1	—	—	= 1	—	—	—	—	= —	—	—	—	1	= 1	6	2	1	1	4
1 M. & F.	1	—	—	5	= 6	1	—	—	4	= 5	1	1	—	—	= 2	1	—	—	—	= 1	1	—	—	—	= 1	2	—	—	1	= 3	1	1	—	—	= 2	2	—	—	—	= 2	1	—	—	3	= 4	13	5	4	4	13
2 M.	1	—	1	1	= 3	—	—	1	1	= 2	1	—	—	—	= 1	1	—	—	1	= 2	2	—	—	—	= 3	10	—	—	—	= 10	1	—	—	—	= 1	—	1	—	—	= 1	6	6	11	1	18
2 F.	—	—	1	—	= 1	—	—	—	1	= 1	2	—	—	—	= 2	—	—	—	—	= —	2	2	—	—	= 4	—	—	—	—	= —	1	—	—	—	= 1	1	1	—	—	= 2	2	6	1	2	9
2 M. & F.	1	—	2	1	= 4	—	—	1	2	= 3	3	—	—	—	= 3	1	—	—	1	= 2	5	2	—	—	= 7	10	—	—	—	= 10	2	—	—	—	= 2	1	2	—	—	= 3	8	12	12	3	27
3 M.	1	—	1	—	= 2	1	—	—	2	= 3	1	—	—	—	= 1	2	—	—	—	= 2	9	—	1	—	= 10	5	—	—	—	= 5	10	—	—	—	= 10	7	—	1	—	= 8	4	—	—	—	= 4	6	17	18	4	39
3 F.	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	2	—	—	—	= 3	—	—	—	1	= 1	1	1	1	—	= 3	3	—	—	—	= 3	1	—	—	—	= 1	—	—	—	—	= —	1	7	4	—	11
3 M. & F.	2	—	1	—	= 3	1	—	—	2	= 3	1	—	—	—	= 1	4	—	1	—	= 5	9	—	1	1	= 11	6	1	1	—	= 8	13	—	—	—	= 13	8	—	1	—	= 9	4	—	—	—	= 4	7	24	22	4	50
4 M.	—	—	—	—	= —	2	—	—	—	= 2	—	—	—	—	= —	2	—	—	—	= 2	3	—	1	—	= 4	7	—	—	1	= 8	5	—	1	2	= 8	11	—	1	—	= 12	4	—	—	—	= 4	2	14	20	4	38
4 F.	—	—	—	1	= 1	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	2	—	—	1	= 3	1	—	—	—	= 1	—	—	—	1	= 1	5	—	—	—	= 5	—	—	—	—	= —	1	4	6	—	10
4 M. & F.	—	—	—	1	= 1	2	—	—	—	= 2	—	—	—	—	= —	2	—	—	—	= 2	5	—	1	1	= 7	8	—	—	1	= 9	5	—	1	3	= 9	16	—	1	—	= 17	4	—	—	—	= 4	3	18	26	4	48
5 M.	—	—	—	1	= 1	1	—	—	—	= 1	—	—	—	—	= —	3	1	—	—	= 4	8	—	—	—	= 8	9	—	2	—	= 11	13	—	2	—	= 15	4	—	—	—	= 4	5	—	—	2	= 7	2	23	19	7	49
5 F.	—	—	—	—	= —	2	—	—	1	= 3	—	—	—	—	= —	—	—	—	1	= 1	2	—	2	—	= 4	—	—	—	—	= —	4	1	—	—	= 5	—	1	—	—	= 1	3	5	5	1	11
5 M. & F.	—	—	—	1	= 1	3	—	—	1	= 4	—	—	—	—	= —	3	1	—	—	= 4	8	—	—	1	= 9	11	—	4	—	= 15	13	—	2	—	= 15	8	1	—	—	= 9	5	1	—	2	= 8	5	28	24	8	60
6 M.	—	—	—	—	= —	4	—	1	—	= 5	2	—	—	—	= 2	4	—	—	—	= 4	14	—	1	1	= 16	10	2	3	2	= 17	9	—	1	2	= 12	17	1	1	1	= 20	6	—	2	—	= 8	7	37	32	8	77
6 F.	1	—	—	—	= 1	—	—	1	—	= 1	—	—	—	—	= —	1	—	—	—	= 1	1	—	—	—	= 1	4	—	—	—	= 4	3	—	—	—	= 3	3	—	1	—	= 4	5	—	—	1	= 6	2	7	7	6	20
6 M. & F.	1	—	—	—	= 1	4	—	2	—	= 6	2	—	—	—	= 2	5	—	—	1	= 6	15	—	1	1	= 17	14	2	3	2	= 21	12	—	1	2	= 15	20	1	2	1	= 24	11	—	2	1	= 14	9	44	39	14	97
7 M.	—	—	—	—	= —	1	—	—	1	= 2	—	—	—	—	= —	1	—	—	—	= 1	8	—	—	1	= 9	7	3	2	—	= 12	3	—	1	—	= 4	4	—	3	—	= 7	7	—	2	—	= 9	2	22	11	9	42
7 F.	—	—	—	—	= —	—	—	—	—	= —	1	—	—	—	= 1	—	—	—	1	= 1	2	—	—	1	= 3	—	1	1	1	= 3	—	—	—	—	= —	1	—	—	1	= 2	1	—	—	—	= 1	1	7	2	1	10
7 M. & F.	—	—	—	—	= —	1	—	—	1	= 2	1	—	—	—	= 1	1	—	—	1	= 2	10	—	—	2	= 12	7	4	3	1	= 15	3	—	1	—	= 4	5	—	3	1	= 9	8	—	2	—	= 10	3	29	13	10	52
8 M.	—	—	—	1	= 1	1	—	—	—	= 1	1	—	—	—	= 1	—	1	—	—	= 1	3	—	—	—	= 3	2	—	1	—	= 3	—	—	1	—	= 1	4	—	—	1	= 5	—	—	—	—	= —	3	7	6	—	13
8 F.	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	1	—	—	—	= 1	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	1	1	2	—	3
8 M. & F.	1	—	—	1	= 2	1	—	—	—	= 1	1	—	—	—	= 1	—	1	—	—	= 1	3	—	—	—	= 3	3	—	1	—	= 4	—	—	2	—	= 2	5	—	—	1	= 6	—	—	—	—	= —	4	8	8	—	16
9 M.	—	—	—	—	= —	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	3	—	—	—	= 3	—	—	—	—	= —	2	—	—	—	= 2	2	—	—	—	= 2	—	—	—	—	= —	1	3	4	—	7
9 F.	—	—	1	—	= 1	2	—	—	—	= 2	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	1	—	—	—	= 1	1	—	—	—	= 1	1	—	—	—	= 1	1	—	—	—	= 1	4	1	2	1	4
9 M. & F.	—	—	1	—	= 1	3	—	—	—	= 3	1	—	—	—	= 1	—	—	—	—	= —	3	—	—	—	= 3	1	—	—	—	= 1	3	—	—	—	= 3	3	—	—	—	= 3	1	—	—	—	= 1	5	4	6	1	11
10 M.	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	1	—	—	—	= 1	—	—	—	—	= —	1	—	—	1	= 2	1	—	—	—	= 1	2	—	—	—	= 2	—	—	—	—	= —	—	3	3	—	6
10 F.	1	—	—	—	= 1	—	—	—	1	= 1	1	—	—	—	= 1	—	—	1	—	= 1	—	—	—	—	= —	—	—	—	—	= —	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	1	= 1	3	1	1	1	3
10 M. & F.	1	—	—	—	= 1	—	—	—	1	= 1	1	—	—	—	= 1	1	—	1	—	= 2	—	—	—	—	= —	1	—	—	1	= 2	2	—	—	—	= 2	2	—	—	—	= 2	—	—	—	1	= 1	3	4	4	1	9
11 M.	3	—	1	—	= 4	1	—	—	—	= 1	1	—	—	—	= 1	—	—	—	—	= —	—	—	1	—	= 1	3	—	—	—	= 3	2	—	—	—	= 2	1	1	—	—	= 2	—	—	—	—	= —	6	4	4	—	8
11 F.	—	—	—	—	= —	—	—	—	—	= —	1	—	—	—	= 1	1	—	1	—	= 2	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	1	3	—	—	= 3	1	3	—	—	3
11 M. & F.	3	—	1	—	= 4	1	—	—	—	= 1	2	—	—	—	= 2	—	—	—	—	= —	1	—	2	—	= 3	4	—	—	—	= 4	2	—	—	—	= 2	1	1	—	—	= 2	—	—	—	—	= —	7	7	4	—	11
12 M.	—	—	—	—	= —	4	—	2	—	= 6	1	—	—	—	= 1	—	—	—	—	= —	1	1	—	—	= 2	2	—	—	—	= 2	1	—	—	—	= 1	2	—	1	—	= 3	1	—	—	—	= 1	7	4	4	1	9
12 F.	—	—	—	—	= —	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	1	—	—	—	= 1	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	1	—	1	—	1
12 M. & F.	—	—	—	—	= —	5	—	2	—	= 7	1	—	—	—	= 1	—	—	—	—	= —	1	1	—	—	= 2	2	—	—	—	= 2	2	—	—	—	= 2	2	—	1	—	= 3	1	—	—	—	= 1	8	4	5	1	10
13 M.	1	—	—	1	= 2	1	—	—	—	= 1	—	—	—	—	= —	—	—	1	—	= 1	—	—	—	—	= —	2	—	—	—	= 2	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	3	1	3	—	4
13 F.	1	—	1	—	= 2	1	—	—	—	= 1	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	—	—	—	—	= —	4	—	—	—	—
13 M. & F.	2	—	1	1	= 4	2	—	—	—	= 2	1	—	—	—	= 1	—	—	1	—	= 1	—	—	—	—	= —	2	—	—	—	= 2	1	—	—	—	= 1	—	—	—	—	= —	—	—	—	—	= —	7	1	3	—	4
Whole Year																																																		
M.	7	—	3	8	= 18	17	—	4	5	= 26	8	—	—	—	= 8	15	2	—	—	= 17	51	1	5	3	= 60	50	5	8	4	= 67	59	—	6	4	= 69	58	2	7	2	= 69	28	1	4	4	= 37	52	144	138	37	319
F.	5	—	3	2	= 10	7	—	1	6	= 14	5	1	—	—	= 6	5	—	2	2	= 9	6	—	1	4	= 11	14	4	4	2	= 24	9	1	1	1	= 12	17	1	1	1	= 20	8	2	—	3	= 13	30	44	32	13	89
M. & F.	12	—	6	10	= 28	24	—	5	11	= 40	13	1	—	—	= 14	20	2	2	2	= 26	57	1	6	7	= 71	64	9	12	6	= 91	68	1	7	5	= 81	75	3	8	3	= 89	36	3	4	7	= 50	82	188	170	50	408

Table VII.

Showing the Annual Deaths from Pneumonia is the Entire District and in the several Sanitary Districts from 1880 to 1887, arranged in Age-Groups.

1880–1887. *Whole Year.*

Years.	0–	15–	45–	65 up.	Total. All Ages.	Total. 15 up.	Years.	0–	15–	45–	65 up.	Total. All Ages.	Total. 15 up.	Years.	0–	15–	45–	65 up.	Total. All Ages.	Total. 15 up.
	Middlesbrough.							*Ormesby.*							*Normanby.*					
1880	41	26	18	5	90	49	1880	10	2	2	—	14	4	1880	13	8	3	2	26	13
1881	17	34	14	7	72	55	1881	8	—	—	—	8	—	1881	12	5	3	1	19	7
1882	56	50	19	10	135	79	1882	4	6	2	—	12	8	1882	15	7	1	1	24	9
1883	30	42	38	10	120	90	1883	3	4	6	2	15	12	1883	11	8	4	1	24	13
1884	30	28	18	5	81	51	1884	8	2	1	—	11	3	1884	6	3	4	—	13	7
1885	31	35	30	8	104	73	1885	19	3	2	1	25	6	1885	11	4	3	—	18	7
1886	47	35	44	9	135	88	1886	4	2	3	—	9	5	1886	6	8	7	2	23	17
1887	49	48	30	10	137	88	1887	13	4	2	3	22	9	1887	11	9	4	5	29	18
	301	298	211	64	874	573		69	23	18	6	116	47		85	50	29	12	176	91

Years.	0–	15–	45–	65 up.	Total. All Ages.	Total. 15 up.	Years.	0–	15–	45–	65 up.	Total. All Ages.	Total. 15 up.
	Eston.							*Entire District.*					
1880	16	2	3	1	22	6	1880	80	38	26	8	152	72
1881	—	5	5	—	10	10	1881	37	42	22	8	109	72
1882	10	11	10	1	32	22	1882	85	74	32	12	203	118
1883	7	5	6	1	19	12	1883	51	59	54	14	178	127
1884	16	10	2	—	28	12	1884	60	43	25	5	133	73
1885	24	5	7	1	37	13	1885	85	47	42	10	184	99
1886	21	9	6	2	38	17	1886	78	54	60	13	205	127
1887	14	3	10	3	30	16	1887	87	64	46	21	218	131
	108	50	49	9	216	108	8 yrs.	563	421	307	91	1,382	819

Table VIII.

Showing the Deaths Registered as from Pneumonia in certain Age-Groups during certain Periods of the Years 1880 to 1887 inclusive.

Year.	First Four Weeks.						Epidemic Period.						Post-Epidemic Period.					
	0-	15-	45-	65 up.	Total. All Ages.	Total. 15 up.	0-	15-	45-	65 up.	Total. All Ages.	Total. 15 up.	0-	15-	45-	65 up.	Total, All Ages.	Total, 15 up.
Middlesbrough.																		
1880	2	4	2	—	8	6	15	7	10	2	34	19	24	15	6	3	48	24
1881	1	4	1	—	6	5	11	19	9	6	45	34	5	11	4	1	21	16
1882	3	2	—	3	8	5	30	28	13	4	75	45	23	20	6	3	52	29
1883	2	3	3	1	9	7	6	27	26	6	65	59	22	12	9	3	46	24
1884	—	1	—	—	1	1	5	18	12	3	38	33	25	9	6	2	42	17
1885	5	1	1	—	7	2	17	17	17	6	57	40	9	17	12	2	40	31
1886	6	2	1	1	10	4	23	21	25	5	74	51	18	12	18	3	51	33
1887	2	6	3	—	11	9	34	27	22	9	92	58	13	15	5	1	34	21
	21	23	11	5	60	39	141	164	134	41	480	339	139	111	66	18	334	195
Ormesby.																		
1880	1	1	1	—	3	2	4	1	1	—	6	2	5	—	—	—	5	—
1881	2	—	—	—	2	—	6	—	—	—	6	—	—	—	—	—	—	—
1882	—	—	—	—	—	—	—	1	1	—	2	2	4	5	1	—	10	6
1883	1	—	—	—	1	—	—	3	4	2	9	9	2	1	2	—	5	3
1884	—	—	—	—	—	—	1	2	—	—	3	2	7	—	1	—	8	1
1885	11	—	—	—	11	—	7	2	2	1	12	5	1	1	—	—	2	1
1886	1	—	1	—	2	1	2	2	—	—	4	2	1	—	2	—	3	2
1887	—	—	—	—	—	—	4	3	2	1	10	6	9	1	—	2	12	3
	16	1	2	—	19	3	24	14	10	4	52	28	29	8	6	2	45	16
Normanby.																		
1880	1	—	—	—	1	—	3	5	1	2	11	8	9	3	2	—	14	5
1881	1	—	—	—	1	—	9	2	—	1	12	3	2	1	3	—	6	4
1882	2	1	—	—	3	1	3	3	1	—	7	4	10	3	—	1	14	4
1883	—	—	1	—	1	1	3	5	2	1	11	8	8	3	1	—	12	4
1884	2	1	—	—	3	1	2	1	3	—	6	4	2	1	1	—	4	2
1885	1	—	—	—	1	—	9	3	—	—	12	3	1	1	3	—	5	4
1886	—	—	—	—	—	—	4	5	6	1	16	12	2	3	1	1	7	5
1887	—	1	—	—	1	1	5	5	4	4	18	13	6	3	—	1	10	4
	7	3	1	—	11	4	38	29	17	9	93	55	40	18	11	3	72	32
Eston.																		
1880	—	—	1	—	1	1	—	2	1	—	3	3	16	—	1	1	18	2
1881	—	1	—	—	1	1	—	3	4	—	7	7	—	1	1	—	2	2
1882	1	1	1	—	3	2	2	4	5	1	12	10	7	6	4	—	17	10
1883	—	—	—	—	—	—	—	5	6	1	12	12	7	—	—	—	7	—
1884	1	1	—	—	2	1	2	4	2	—	8	6	13	5	—	—	18	5
1885	7	—	1	1	9	2	10	4	3	—	17	7	7	1	3	—	11	4
1886	1	—	1	1	3	2	12	5	3	1	21	9	8	4	2	—	14	6
1887	—	—	1	—	1	1	4	1	3	—	8	4	10	2	8	1	21	11
	10	3	5	2	20	10	30	28	27	3	88	58	68	19	19	2	108	40
Entire District.																		
1880	4	5	4	—	13	9	22	15	13	4	54	32	54	18	9	4	85	31
1881	4	5	1	—	10	6	26	24	13	7	70	44	7	13	8	1	29	22
1882	6	4	1	3	14	8	35	36	20	5	96	61	44	34	11	4	93	49
1883	3	3	4	1	11	8	9	40	38	10	97	88	39	16	12	3	70	31
1884	3	3	—	—	6	3	10	25	17	3	55	45	47	15	8	2	72	25
1885	24	1	2	1	28	4	43	26	22	7	98	55	18	20	18	2	58	40
1886	8	2	3	2	15	7	41	33	34	7	115	74	29	19	23	4	75	46
1887	2	7	4	—	13	11	47	36	31	14	128	81	38	21	13	5	77	39
	54	30	19	7	110	56	233	235	188	57	713	480	276	156	102	25	559	283

Table IX.

Showing the Number of Cases of each Sex and Age-Group treated by Eleven Medical Practitioners, and the Number of them that were Fatal during Three Months antecedent to the Commencement of the Epidemic, and during each Four-Weekly Period of the Epidemic Prevalence. [Cases in Workhouse excluded.]

Ages.	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
November 1, 1887, to January 28, 1888.	27	20	= 47	24	9	= 33	16	3	= 19	1	3	= 4	41	15	= 56	68	35	=103
Epidemic Period.																		
1888. January 29 to February 25	24	2	= 26	18	8	= 26	7	4	= 11	—	1	= 1	25	13	= 38	49	15	= 64
February 26 to March 24 -	23	12	= 35	37	3	= 40	14	6	= 20	2	—	= 2	53	9	= 62	76	21	= 97
March 25 to April 21 -	23	9	= 32	49	16	= 65	21	9	= 30	2	3	= 5	72	28	=100	95	37	=132
April 22 to May 19 -	24	39	= 63	53	16	= 69	19	7	= 26	6	2	= 8	78	25	=103	102	64	=166
May 20 to June 13 -	21	17	= 38	72	8	= 80	22	7	= 29	7	4	= 11	101	19	=120	122	36	=158
June 17 to July 14 -	8	5	= 13	34	7	= 41	5	3	= 8	1	2	= 3	40	12	= 52	48	17	= 65
Totals of Six Epidemic Months.	123	84	=207	263	58	=321	88	36	=124	18	12	= 30	369	106	=475	492	190	=682
Numbers of the above Cases that were Fatal.																		
November 1, 1887, to January 28, 1888.	3	5	= 8	3	1	= 4	4	—	= 4	1	2	= 3	8	3	= 11	11	8	= 19
Epidemic Period.																		
1888. January 29 to February 25	7	—	= 7	4	1	= 5	2	—	= 2	—	1	= 1	6	2	= 8	13	2	= 15
February 26 to March 24 -	—	1	= 1	8	2	= 10	7	1	= 8	—	—	= —	15	3	= 18	15	4	= 19
March 25 to April 21 -	2	—	= 2	8	5	= 13	9	2	= 11	—	1	= 1	17	8	= 25	19	8	= 27
April 22 to May 19 -	2	2	= 4	15	2	= 17	8	2	= 10	1	2	= 3	24	6	= 30	26	8	= 34
May 20 to June 16 -	1	1	= 2	13	1	= 14	8	3	= 11	3	3	= 6	24	7	= 31	25	8	= 33
June 17 to July 14 -	1	—	= 1	7	1	= 8	3	1	= 4	1	1	= 2	11	3	= 14	12	3	= 15
Total of Six Epidemic Months.	13	4	= 17	55	12	= 67	37	9	= 46	5	8	= 13	97	29	=126	110	33	=143
Number per Cent. of the above Cases that were Fatal.																		
November 1, 1887, to January 28, 1888.	11·1	25·0	= 17·0	12·5	11·1	= 12·1	25·0	—	= 21·1	100·0	66·6	= 75·0	19·5	20·0	= 19·6	16·2	22·9	= 18·4
Epidemic Period.																		
1888. January 29 to February 25	29·2	—	= 26·9	22·2	12·5	= 19·2	28·6	—	= 18·2	—	100·0	=100·0	24·0	15·4	= 21·1	26·5	13·3	= 23·4
February 26 to March 24 -	—	8·3	= 2·9	21·6	66·6	= 25·0	50·0	16·6	= 40·0	—	—	= —	28·3	33·3	= 29·	19·7	19·0	= 19·6
March 25 to April 21 -	8·7	—	= 6·1	16·3	31·2	= 20·0	42·9	22·2	= 36·7	—	33·3	= 20·0	23·6	28·	= 25·	20·0	21·6	= 20·5
April 22 to May 19 -	8·3	5·1	= 6·3	28·3	12·5	= 24·6	42·1	28·6	= 38·5	16·7	100·0	= 37·5	30·8	24·0	= 29·1	25·5	12·5	= 20·5
May 20 to June 16 -	4·8	5·9	= 5·3	18·1	12·5	= 17·5	36·4	42·9	= 37·9	42·9	75·0	= 54·5	23·8	36·8	= 25·8	20·5	22·2	= 20·9
June 17 to July 17 -	12·5	—	= 7·7	20·6	14·3	= 19·5	60·0	33·3	= 50·0	100·0	50·0	= 66·6	27·5	25·0	= 26·9	25·0	17·6	= 23·1
Mean of Six Epidemic Months.	10·6	4·8	= 8·2	20·9	20·7	= 20·9	42·0	25·	= 37·1	27·8	66·6	= 43·3	26·3	27·4	= 26·5	22·4	17·4	= 21·1

App. A. No. 18.

On Pleuro-pneumonic Fever in Middlesbrough and neighbourhood; by Dr. Ballard.

Table X.

November 1887 to end of Year 1888.

Showing the Cases, Inmates and Non-Inmates, treated for Pneumonia in Middlesbrough Workhouse.

Inmate.	Day of Week.	Date of Attack, or, if not Inmate, of Admission for Treatment.	Sex.	Age.	Result (Date of Death). R. = Recovered.	
		1887. Nov. 18	M.	31	1887. Nov. 21 -	During three months prior to epidemic outbreak.
I.	T.	„ 22	M.	39	„ 26 -	
I.	Th.	Dec. 8	F.	9	R. - -	
I.	Th.	„ 22	F.	4	R. - -	
		„ 22	F.	19	R. - -	
		„ 24	M.	38	Dec. 30 -	
		„ 28	M.	37	R. - -	
I.	Sat.	„ 31	M.	71	1888. Jan. 9 -	
		1888. Jan. 14	M.	61	„ 16 -	
I.	F.	„ 27	M.	16	R. - -	
I.	Sat.	„ 28	F.	35	Jan. 39 -	
		Feb. 3	M.	50	R. - -	1st 4-weekly period of epidemic.
		„ 1	M.	47	Feb. 8 -	
I.	W.	„ 8	M.	35	R. - -	
		„ 12	M.	36	R. - -	
I.	W.	„ 15	F.	6	R. - -	
I.	T.	„ 21	F.	4	R. - -	
I.	W.	„ 22	F.	44	Feb. 28 -	
I.	Th.	„ 23	M.	60	„ 26 -	
		„ 24	M.	31	March 1 -	
		„ 24	M.	45	„ 1 -	
I.	Sat.	„ 25	M.	8	R. - -	

Table X.—*continued.*

mate.	Day of Week.	Date of Attack, or, if not Inmate, of Admission for Treatment.	Sex.	Age.	Result (Date of Death). R.=Recovered.	—
I.	Sun.	Feb. 26	M.	55	Feb. 29 -	
I.	M.	„ 27	F.	3	R. - -	
I.	M.	„ 27	M.	66	Feb. 29 -	
I.	F.	March 2	M.	4	R. - -	
I.	F.	„ 2	M.	6	R. - -	
I.	Sat.	„ 3	M.	5	R. - -	
I.	W.	„ 7	M.	7	R. - -	
I.	Th.	„ 8	M.	11	R. - -	
		„ 9	M.	46	March 11 -	2nd 4-weekly period of epidemic.
		(Taken ill Mar. 4).				
		„ 10	M.	31	„ 20 -	
		„ 11	M.	68	R. - -	
		„ 14	M.	42	R. - -	
		„ 14	M.	15	R. - -	
		„ 14	M.	35	March 17 -	
		„ 15	M.	33	R. - -	
		„ 29	M.	65	April 25 -	
I.	Th.	„ 27	F.	40–50	R. - -	
I.	Th.	April 5	F.	13	R. - -	
		„ 6	M.	36	April 26 -	
		„ 6	M.	19	R. - -	
		„ 6	M.	39	R. - -	
		„ 9	M.	44	R. - -	
		„ 9	M.	26	April 13 -	
		„ 11	M.	46	R. - -	
		„ 12	M.	32	April 16 -	
		„ 16	M.	48	„ 21 -	3rd 4-weekly period of epidemic.
		„ 16	M.	46	R. - -	
		„ 18	M.	62	May 16 -	
		„ 19	M.	60	R. - -	
		„ 19	M.	31	Removed in unfit state, but name not on death registers.	
		„ 19	F.	4	R. - -	
I.	Sun.	„ 20	F.	14	R. - -	
		„ 21	M.	36	R. - -	
		„ 21	M.	47	April 25 -	

Table X.—*continued.*

Inmate.	Day of Week.	Date of Attack, or, if not Inmate, of Admission for Treatment.	Sex.	Age.	Result (Date of Death). R.=Recovered.	—
		May 2	M.	54	May 8 -	4th 4-weekly period of epidemic.
		„ 4	M.	50	R. - -	
		„ 7	M.	42	R. -	
		„ 15	F.	40	May 19 -	
		„ 17	M.	54	R. - -	
		„ 17	M.	39	May 22 -	
I.	Th.	„ 17	M.	66	„ 22 -	
I.	Th.	„ 17	F.	9	R. - -	
		„ 18	M.	55	May 23 -	
		„ 19	M.	32	R. - -	
		„ 22	M.	39	May 25 -	5th 4-weekly period of epidemic.
		„ 24	M.	33	R. - -	
		„ 25	M.	57	June 6	
		„ 26	M.	40	May 29 -	
I.	M.	„ 28	M.	57	June 4 -	
I.	F.	June 1	M.	11	R. - -	
I.	Sat.	„ 2	M.	56	R. - -	
I.	Sun.	„ 3	F.	9	R. - -	
		„ 4	M.	30	R. - -	
I.	T.	„ 5	M.	72	June 7 -	
		„ 6	M.	42	„ 7 -	
		„ 10	M.	33	R. - -	
		„ 12	F.	18	R. - -	
		„ 13	M.	65	R. - -	
I.	W.	„ 13	M.	72	June 17 -	
		„ 13	M.	39	R. - -	
I.	Th.	„ 14	M.	65	June 17 -	
I.	Sat.	„ 16	F.	6	R. - -	
		„ 21	F.	60	June 28 -	6th 4-weekly period of epidemic.
I.	Th.	„ 28	F.	7	R. - -	
I.	F.	„ 29	M.	5	R. - -	
I.	Sun.	July 1	M.	71	July 5 -	
		„ 4	M.	34	R. - -	
I.	M.	„ 9	F.	29	R. - -	
		„ 12	M.	34	July 16 -	

Table X.—*continued.*

Inmate.	Day of Week.	Date of Attack, or, if not Inmate, of Admission for Treatment.	Sex.	Age.	Result (Date of Death). R. = Recovered.	
		July 18	M.	60	July 20 -	1st 4-weekly post-epidemic period.
I.	T.	„ 17	F.	36	„ 22 -	
I.	Sun.	„ 22	F.	7	R. - -	
I.	M.	„ 23	F.	6	Aug. 22 -	2nd 4-weekly post-epidemic period.
		Aug. 6	M.	40	R. - -	
		Sept. 11	M.	60	Sept. 16 -	3rd 4-weekly post-epidemic period.
		„ 21	F.	36	R. - -	
		Oct. 19	M.	51	R. - -	
		„ 19	M.	23	R. - -	
		„ 25	M.	22	R. - -	
		„ 27	M.	48	Nov. 3 -	4th 4-weekly post-epidemic period.
I.	F.	„ 27	M.	38	Nov. 16 -	5th 4-weekly post-epidemic period.
		Nov. 2	M.	2	„ 4 -	
I.	Sun.	„ 6	M.	53	R. - -	
		„ 11	M.	8	R. - -	
		„ 15	M.	44	R. - -	
		„ 16	M.	56	Nov. 16 -	
		„ 17	M.	36	R. - -	
		„ 27	M.	18	R. - -	
I.	M.	Dec. 10	M.	53	Dec. 15 -	6th 4-weekly post-epidemic period.

Table XI.

Cases of Pneumonia treated in the Workhouse from November 1, 1887, to December 31, 1888, arranged in Age-Groups and Periods of Time, and distinguishing the Sexes; and showing the Number and Proportion of these Cases that were Fatal; distinguishing also Inmates and Non-Inmates.

(*a.*) *Inmates.*

Cases.

Ages.	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
November 1, 1887, to January 28, 1888.	—	2	= 2	2	1	= 3	—	—	= —	1	—	= 1	3	1	= 4	3	3	= 6
1888. January 29 to July 14 -	8	9	= 17	1	2	= 3	4	1	= 5	6	—	= 6	11	3	= 14	19	12	= 31
July 15 to December 31 -	1	3	= 4	—	1	= 1	1	—	= 1	—	—	= —	1	1	= 2	2	4	= 6
Total, January 29 to December 31.	9	12	= 21	1	3	= 4	5	1	= 6	6	—	= 6	12	4	= 16	21	16	= 37
Total, November 1, 1887, to December 31, 1888.	9	14	= 23	3	4	= 7	5	1	= 6	7	—	= 7	15	5	= 20	24	19	= 43
Numbers of above Cases that were Fatal.																		
November 1, 1887, to January 28, 1888.	—		= —	1	1	= 2	—	—	= —	1	—	= 1	2	1	= 3	2	1	= 3
1888. January 29 to July 14 -	—	—	= —	—	1	= 1	3	—	= 3	6	—	= 6	9	1	= 10	9	1	= 10
July 15 to December 31 -	1	1	= 2	—	1	= 1	1	—	= 1	—	—	= —	1	1	= 2	2	2	= 4
Total, January 29 to December 31.	1	1	= 2	—	2	= 2	4	—	= 4	6	—	= 6	10	2	= 12	11	3	= 14
Total, November 1, 1887, to December 31, 1888.	1	1	= 2	1	3	= 4	4	—	= 4	7	—	= 7	12	3	= 15	13	4	= 17
Number per Cent. of Cases that were Fatal.																		
November 1, 1887, to January 28, 1888.	—	—	= —	50·0	100·0	= 66·6	—	—	= —	100·0	—	=100·0	66·6	100·0	= 75·0	66·0	33·3	= 50·0
1888. January 29 to July 14 -	—	—	= —	—	50·0	= 33·3	75·0	—	= 60·0	100·0	—	=100·0	81·8	33·3	= 71·4	47·4	8·3	= 32·3
July 15 to December 31 -	100·0	33·3	=50·0	—	100·0	=100·0	100·0	—	=100·0	—	—	= —	100·0	100·0	=100·0	100·0	50·0	= 66·6
Mean, January 29 to December 31.	11·1	8·3	= 9·5	—	66·6	= 50·0	80·0	—	= 66·6	100·0	—	=100·0	83·3	50·0	= 75·0	52·4	18·7	= 37·8
Mean, November 1, 1887, to December 31, 1888.	11·1	7·1	= 8·7	33·3	75·0	= 57·1	80·0	—	= 66·6	100·0	—	=100·0	80·0	60·0	= 75·0	54·2	21·1	= 39·5
Cases, January 1 to January 27 (1st 4-Weekly Period of Year).																		
——	—	—	= —	1	1	= 2	—	—	= —	—	—	= —	1	1	= 2	1	1	= 2
Number of above Cases that were Fatal.																		
——	—	—	= —	—	1	= 1	—	—	= —	—	—	= —	—	1	= 1	—	1	= 1
Number per Cent. of above Cases that were Fatal.																		
——	—	—	= —	—	100·0	= 50·0	—	—	= —	—	—	= —	—	100·0	= 50·0	—	100·0	= 50·0
Cases, whole Year, 1888, January 1 to December 31.																		
——	9	12	= 21	2	4	= 6	5	1	= 6	6	—	= 6	13	5	= 18	22	17	= 39
Number of above Cases that were Fatal.																		
——	1	1	= 2	—	3	= 3	4	—	= 4	6	—	= 6	10	3	= 13	11	4	= 15
Number per Cent. of above Cases that were Fatal.																		
——	11·1	8·3	= 9·5	—	75·0	= 50·0	80·0	—	= 66·6	100·0	—	=100·0	76·9	60·0	= 72·2	50·0	23·5	= 38·5

TABLE XI.—*continued.*

(*b.*) *Non-Inmates.*

CASES.

Ages.	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
November 1, 1887, to January 28, 1888.	—	—	= —	3	1	= 4	1	—	= 1	—	—	= —	4	1	= 5	4	1	= 5
1888. January 29 to July 14 -	—	1	= 1	27	2	= 29	15	1	= 16	3	—	= 3	45	3	= 48	45	4	= 49
July 15 to December 31 -	—	—	= —	7	1	= 8	6	—	= 6	3	—	= 3	16	1	= 17	16	1	= 17
Total, January 29 to December 31.	—	1	= 1	34	3	= 37	21	1	= 22	6	—	= 6	61	4	= 65	61	5	= 66
Total, November 1, 1887, to December 31, 1888.	—	1	= 1	37	4	= 41	22	1	= 23	6	—	= 6	65	5	= 70	65	6	= 71
NUMBERS of above CASES that were FATAL.																		
November 1, 1887, to January 28, 1888.	—	—	= —	2	—	= 2	1	—	= 1	—	—	= —	3	—	= 3	3	—	= 3
1888. January 29 to July 14 -	—	—	= —	11	1	= 12	9	1	= 10	1	—	= 1	21	2	= 23	21	2	= 23
July 15 to December 31 -	—	—	= —	1	—	= 1	4	—	= 4	—	—	= —	5	—	= 5	5	—	= 5
Total, January 29 to December 31.	—	—	= —	12	1	= 13	13	1	= 14	1	—	= 1	26	2	= 28	26	2	= 28
Total, November 1, 1887, to December 31, 1888.	—	—	= —	14	1	= 15	14	1	= 15	1	—	= 1	29	2	= 31	29	2	= 31
NUMBER PER CENT. of CASES that were FATAL.																		
November 1, 1887, to January 28, 1888.	—	—	= —	66·6	—	= 50	100·0	—	=100·0	—	—	= —	75·0	—	= 60·0	75·0	—	= 60·0
1888. January 29 to July 14 -	—	—	= =	40·7	50·0	= 41·4	60·0	100·0	= 62·5	33·3	—	= 33·3	46·7	66·0	= 47·9	46·7	50·0	= 47·1
July 15 to December 31 -	—	—	= —	14·3	—	= 12·5	66·6	—	= 66·6	—	—	= —	31·2	—	= 29·4	31·2	—	= 29·4
Total, January 29 to December 31.	—	—	= —	35·3	33·3	= 35·1	69·1	100·0	= 63·6	16·6	—	= 16·6	42·6	50·0	= 43·1	42·6	40·0	= 42·4
Total, November 1, 1887, to December 31, 1888.	—	—	= —	37·8	25·0	= 36·6	63·6	100·0	= 65·2	16·6	—	= 16·6	41·6	40·0	= 44·3	44·6	33·3	= 43·7
CASES, JANUARY 1 to JANUARY 27 (1st 4-Weekly Period of Year).																		
——	—	—	= —	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	1	—	= 1
NUMBER of above CASES that were FATAL.																		
——	—	—	= —	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	1	—	= 1
NUMBER PER CENT. of above CASES that were FATAL.																		
——	—	—	= —	—	—	= —	100·0	—	=100·0	—	—	= —	100·0	—	=100·0	1	—	=100·0
CASES, WHOLE YEAR, 1888, JANUARY 1 to DECEMBER 31.																		
——	—		= 1	34	3	= 37	22	1	= 23	6	—	= 6	62	4	= 66	62	5	= 67
NUMBER of above CASES that were FATAL.																		
——	—	—	= —	12	1	= 13	14	1	= 15	1	—	= 1	27	2	= 29	27	2	= 29
NUMBER PER CENT. of above CASES that were FATAL.																		
——	—	—	= —	35·3	33·3	= 35·1	63·6	100·0	= 65·2	16·6	—	= 16·6	43·	50·0	= 43·9	43·5	40·0	= 40·3

Table XI.—*continued.*

(*c.*) *Inmates and Non-Inmates together.*

Cases.

Ages.	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
November 1, 1887, to January 28, 1888.	—	2	= 2	5	2	= 7	1	—	= 1	1	—	= 1	7	2	= 9	7	4	= 11
1888. January 29 to July 14 -	8	10	= 18	28	4	= 32	19	2	= 21	9	—	= 9	56	6	= 62	64	16	= 80
July 15 to December 31 -	1	3	= 4	7	2	= 9	7	—	= 7	3	—	= 3	17	2	= 19	18	5	= 23
Total, January 29 to December 31.	9	13	= 22	35	6	= 41	26	2	= 28	12	—	= 12	73	8	= 81	82	21	=103
Total, November 1, 1887, to December 31, 1888.	9	15	= 24	40	8	= 48	27	2	= 29	13	—	= 13	80	10	= 90	89	25	=114
Number of above Cases that were Fatal.																		
Total, November 1, 1887, to January 28, 1888.	—	—	= —	3	1	= 4	1	—	= 1	1	—	= 1	5	1	= 6	5	1	= 6
1888. January 29 to July 14 -	—	—	= —	11	2	= 13	12	1	= 13	7	—	= 7	30	3	= 33	30	3	= 33
July 15 to December 31 -	1	1	= 2	1	1	= 2	5	—	= 5	—	—	= —	6	1	= 7	7	2	= 9
Total, January 29 to December 31.	1	1	= 2	12	3	= 15	17	1	= 18	7	—	= 7	36	4	= 40	37	5	= 42
Total, November 1, 1887, to December 31, 1888.	1	1	= 2	15	4	= 19	18	1	= 19	8	—	= 8	41	5	= 46	42	6	= 48
Number per Cent. of Cases that were Fatal.																		
November 1, 1887, to January 28, 1888.	—	—	= —	60·0	50·0	= 57·1	100·0	—	=100·0	100·0	—	=100·0	71·4	50·0	= 66·6	71·4	25·0	= 54·5
1888. January 29 to July 14 -	—	—	= —	39·3	50·0	= 40·6	63·2	50·0	= 61·9	77·8	—	= 77·8	53·6	50·0	= 53·2	46·9	18·7	= 41·2
July 15 to December 31 -	100·0	33·3	= 50·0	14·3	50·0	= 22·2	71·4	—	= 71·4	—	—	= —	35·3	50·0	= 36·8	38·9	40·0	= 39·1
Total, January 29 to December 31.	11·1	7·7	= 9·1	34·3	50·0	= 36·6	65·4	50·0	= 64·3	58·3	—	= 58·3	49·3	50·0	= 49·4	45·1	23·3	= 40·8
Total, November 1, 1887, to December 31, 1888.	11·1	6·7	= 8·3	37·5	50·0	= 39·6	66·6	50·0	= 65·5	61·5	—	= 61·5	51·2	50·0	= 51·1	47·2	24·0	= 42·1

Table XII.

Showing the Cases of Pneumonia and Deaths from Pneumonia in Workhouse during Eight Years 1880–87, arranged in Age-Groups and Periods of Time and distinguishing the Sexes distinguishing also Inmates and Non-Inmates.

(*a.*) *Inmates.*

Cases.

—	0–			15–			45–			65 upwards.			15 upwards.			All Ages.		
1st 4-weekly Period.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	N.	F.	M.F.	M.	F.	M.F.
1880	1	1	= 2	1	—	= 1	1	—	= 1	—	—	= —	2	—	= 2	3	1	= 4
1881	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1882	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1883	—	1	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	1	= 1
1884	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1885	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1886	—	—	= —	1	—	= 1	1	—	= 1	—	—	= —	2	—	= 2	2	—	= 2
1887	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
—	3	2	= 5	2	—	= 2	2	—	= 2	—	—	= —	4	—	= 4	7	2	= 9
Annual average*	0·4	0·25	= 0·6	0·25	—	= 0·25	0·25	—	= 0·25	—	—	= —	0·5	—	= 0·5	0·9	0·25	= 1·1
2nd to 7th Period.																		
1880	1	—	= 1	1	—	= 1	—	—	= —	1	—	= 1	2	—	= 2	3	—	= 3
1881	—	1	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	1	= 1
1882	1	—	= 1	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	2	—	= 2
1883	7	—	= 7	1	—	= 1	1	—	= 1	—	—	= —	2	—	= 2	9	—	= 9
1884	—	1	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	1	= 1
1885	5	3	= 8	—	—	= —	—	—	= —	—	—	= —	—	—	= —	5	3	= 8
1886	3	2	= 5	1	—	= 1	3	1	= 4	—	—	= —	4	1	= 5	7	3	= 10
1887	—	—	= —	—	—	= —	—	—	= —	3	—	= 3	3	—	= 3	3	—	= 3
—	17	7	= 24	3	—	= 3	5	1	= 6	4	—	= 4	12	1	= 13	29	8	= 37
Annual average	2·1	0·9	= 3·0	0·4	—	= 0·4	0·6	0·1	= 0·7	0·5	—	= 0·5	1·5	0·1	= 1·6	3·6	1·0	= 4·6

* These averages may be compared with Table XI.

Table XII.—*continued.*

—	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
8th to 13th Period.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1881	1	—	= 1	1	—	= 1	—	—	= —	—	—	= —	1	—	= 1	2	—	= 2
1882	2	1	= 3	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	3	1	= 4
1883	2	—	= 2	—	—	= —	—	—	= —	—	—	= —	—	—	= —	2	—	= 2
1884	1	2	= 3	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1	2	2	= 4
1885	1	4	= 5	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1	2	4	= 6
1886	2	—	= 2	—	1	= 1	—	—	= —	1	—	= 1	1	1	= 2	3	1	= 4
1887	2	2	= 4	1	—	= 1	—	—	= —	1	—	= 1	2	—	= 2	4	2	= 6
—	11	9	= 20	2	1	= 3	1	—	= 1	4	—	= 4	7	1	= 8	18	10	= 28
Annual average	1·4	1·1	= 2·5	0·25	0·1	= 0·4	0·1	—	= 0·1	0·5	—	= 0·5	0·9	0·1	= 1·0	2·25	1·25	= 3·5
Total whole Period of 8 years.	31	18	= 49	7	1	= 8	8	1	= 9	8	—	= 8	23	2	= 25	54	20	= 74

Total Cases each Year.

—	0-			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	2	1	= 3	4	—	= 4	6	1	= 7
1881	2	1	= 3	1	—	= 1	3	1	= 4
1882	4	1	= 5	2	—	= 2	6	1	= 7
1883	9	1	= 10	2	—	= 2	11	1	= 12
1884	1	3	= 4	1	—	= 1	2	3	= 5
1885	6	7	= 13	1	—	= 1	7	7	= 14
1886	5	2	= 7	7	2	= 9	12	4	= 16
1887	2	2	= 4	5	—	= 5	7	2	= 9
—	31	18	= 49	23	2	= 25	54	20	= 74
Annual average of Cases	3·9	2·2	= 6·1	2·9	0·25	= 3·1	6·7	2·5	= 9·2
Whole of 1888	9	12	= 21	13	5	= 18	22	17	= 39

TABLE XII.—*continued.*

Inmates.

DEATHS.

	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
1st 4-weekly Period.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	—	= —	1	—	= 1	1	—	= 1	—	—	= —	2	—	= 2	2	—	= 2
1881	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1882	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1883	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1884	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1885	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1886	—	—	= —	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	1	—	= 1
1887	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
	2	—	2	1	—	= 1	2	—	= 2	—	—	= —	3	—	= 3	5	—	= 5
Per cent. of cases	66·6	—	= 40·0	50·0	—	= 50·0	100·0	—	=100·0	—	—	= —	75·0	—	= 75·0	71·4	—	= 55·5
2nd to 7th 4-weekly Period.																		
1880	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1881	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1882	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1883	—	—	= —	1	—	= 1	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1
1884	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1885	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1886	1	1	= 2	1	—	= 1	1	1	= 2	—	—	= —	2	1	= 3	3	2	= 5
1887	—	—	= —	—	—	= —	1	—	= 1	2	—	= 2	3	—	= 3	3	—	= 3
	2	1	= 3	2	—	= 2	2	1	= 3	2	—	= 2	6	1	= 7	8	2	= 10
Per cent. of cases	11·8	14·3	= 12·5	66·6	—	= 66·6	40·0	100·0	= 50·0	40·0	—	= 40·0	46·1	100·0	= 50·0	26·6	25·0	= 26·3

Table XII.—*continued.*

——	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
8th to 13th 4-weekly Period.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1881	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1882	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1883	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1884	—	1	= 1	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1	1	1	= 2
1885	—	—	= —	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1	1	—	= 1
1886	—	—	= —	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1	1	—	= 1
1887	—	—	= —	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1	1	—	= 1
——	2	1	= 3	—	—	= —	—	—	= —	4	—	= 4	4	—	= 4	6	1	= 7
Per cent. of cases	18·2	11·1	= 15·0	—	—	= —	—	—	= —	100·0	—	=100·0	57·1	—	= 50·0	33·3	10·0	= 25·0
Whole period of 8 years	6	2	= 8	3	—	= 3	4	1	= 5	6	—	= 6	13	1	= 14	19	3	= 22

Total Deaths each Year.

——	0-			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	—	= —	2	—	= 2	2	—	= 2
1881	1	—	= 1	—	—	= —	1	—	= 1
1882	2	—	= 2	—	—	= —	2	—	= 2
1883	1	—	= 1	1	—	= 1	2	—	= 2
1884	—	1	= 1	1	—	= 1	1	1	= 2
1885	1	—	= 1	1	—	= 1	2	—	= 2
1886	1	1	= 2	4	1	= 5	5	2	= 7
1887	—	—	= —	4	—	= 4	4	—	= 4
Total, whole 8 years	6	2	= 8	13	1	= 14	19	3	= 22
Whole year 1888	-	-	-	-	-	-	-	-	-

Deaths per Cent. of Cases.

	0-			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	—	= —	50·0	—	= 50·0	28·6	—	= 28·6
1881	50·0	—	= 33·3	—	—	= —	25·0	—	= 25·0
1882	50·0	—	= 40·0	—	—	= —	28·6	—	= 28·6
1883	11·0	—	= 10·0	50·0	—	= 50·0	16·6	—	= 16·6
1884	—	33·3	= 25·0	100·0	—	=100·0	50·0	33·3	= 40·0
1885	16·6	—	= 7·7	100·0	—	=100·0	28·6	—	= 14·3
1886	20·0	50·0	= 28·6	57·1	50·0	= 55·5	41·7	50·0	= 43·7
1887	—	—	= —	80·0	—	= 80·0	57·1	—	= 44·4
Total, whole 8 years	19·4	11·1	= 16·3	56·5	50·0	= 56·0	35·2	15·0	= 29·7
Whole year 1888	11·1	8·3	= 9·5	76·9	60·0	= 72·2	50·0	23·5	= 38·5

TABLE XII.—*continued.*

(b.) Non-Inmates.

CASES.

——	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
1st 4-weekly Period.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	—	= —	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	1	—	= 1
1881	—	—	= —	1	1	= 2	1	—	= 1	—	—	= —	2	1	= 3	2	1	= 3
1882	—	—	= —	2	—	= 2	1	—	= 1	—	—	= —	3	—	= 3	3	—	= 3
1883	—	—	= —	1	—	= 1	1	—	= 1	—	—	= —	2	—	= 2	2	—	= 2
1884	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1885	—	—	= —	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	1	—	= 1
1886	1	—	= 1	1	—	= 1	—	—	= —	—	—	= —	1	—	= 1	2	—	= 2
1887	—	—	= —	3	—	= 3	2	—	= 2	—	—	= —	5	—	= 5	5	—	= 5
Total	1	—	= 1	8	1	= 9	7	—	= —	—	—	= —	15	1	= 16	16	1	= 17
Annual average	0·1	—	= 0·1	1·0	0·1	= 1·1	0·9	—	= 0·9	—	—	= —	1·9	0·1	= 2·0	2·0	0·1	= 2·1
2nd to 7th 4-weekly Periods.																		
1880	—	—	= —	5	—	= 5	1	—	= 1	1	—	= 1	7	—	= 7	7	—	= 7
1881	—	—	= —	5	1	= 6	5	—	= 5	—	—	= —	10	1	= 11	10	1	= 11
1882	—	—	= —	4	—	= 4	—	—	= —	—	—	= —	4	—	= 4	4	—	= 4
1883	—	—	= —	9	—	= 9	3	—	= 3	—	—	= —	12	—	= 12	12	—	= 12
1884	—	1	= 1	2	—	= 2	1	—	= 1	—	—	= —	3	—	= 3	3	1	= 4
1885	2	2	= 4	5	—	= 5	—	—	= —	1	—	= 1	6	—	= 6	8	2	= 10
1886	—	2	= 2	4	—	= 4	1	—	= 1	—	—	= —	5	—	= 5	5	2	= 7
1887	—	—	= —	3	—	= 3	3	—	= 3	2	—	= 2	8	—	= 8	8	—	= 8
Total	2	5	= 7	37	1	= 38	14	—	= 14	4	—	= 4	55	1	= 56	57	6	= 63
Annual average	0·25	0·6	= 0·9	4·6	0·1	= 4·7	1·7	—	= 1·7	0·5	—	= 0·5	6·9	0·1	= 7·0	7·1	0·7	= 7·9

Table XII.—*continued.*

——	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
8th to 13th 4-weekly Period.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	1	= 1	1	1	= 2	—	—	= —	—	—	= —	1	1	= 2	1	2	= 3
1881	—	—	= —	5	—	= 5	1	—	= 1	—	—	= —	6	—	= 6	6	—	= 6
1882	1	—	= 1	5	1	= 6	—	—	= —	—	—	= —	5	1	= 6	6	1	= 7
1883	—	—	= —	3	—	= 3	1	—	= 1	—	—	= —	4	—	= 4	4	—	= 4
1884	—	—	= —	2	1	= 3	—	—	= —	1	—	= 1	3	1	= 4	3	1	= 4
1885	2	—	= 2	1	—	= 1	1	1	= 2	—	—	= —	2	1	= 3	4	1	= 5
1886	1	—	= 1	1	1	= 2	2	—	= 2	—	—	= —	3	1	= 4	4	1	= 5
1887	—	—	= —	4	2	= 6	2	—	= 2	—	—	= —	6	1	= 8	6	2	= 8
Total	4	1	= 5	22	6	= 28	7	1	= 8	1	—	= 1	30	7	= 37	34	8	= 42
Annual average	0·5	0·1	= 0·6	2·7	0·7	= 3·5	0·9	0·1	= 1·0	0·1	—	= 0·1	3·7	0·9	= 4·6	4·2	1·0	= 5·2
Total whole period of 8 years.	7	6	= 13	67	8	= 75	28	1	= 29	5	—	= 5	100	9	= 109	107	15	= 122

Total Cases each Year.

——	0-			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	1	= 1	9	1	= 10	9	2	= 11
1881	—	—	= —	18	2	= 20	18	2	= 20
1882	1	—	= 1	12	1	= 13	13	1	= 14
1883	—	—	= —	18	—	= 18	18	—	= 18
1884	—	1	= 1	6	1	= 7	6	2	= 8
1885	4	2	= 6	9	1	= 10	13	3	= 16
1886	2	2	= 4	9	1	= 10	11	3	= 14
1887	—	—	= —	19	2	= 21	19	2	= 21
Total	7	6	= 13	100	9	= 109	107	15	= 122
Annual average of cases	0·87	0·75	= 1·6	12·5	1·1	= 13·6	13·4	1·9	= 15·2
Whole of 1888	—	1	= 1	62	4	= 66	62	5	= 67

TABLE XII.—*continued.*

Non-Inmates.

DEATHS.

——	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1881	—	—	= —	—	1	= 1	1	—	= 1	—	—	= —	1	1	= 2	1	1	= 2
1882	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1883	—	—	= —	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	1	—	= 1
1884	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1885	—	—	= —	—	—	= —	1	—	= 1	—	—	= —	1	—	= 1	1	—	= 1
1886	1	—	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	1	—	= 1
1887	—	—	= —	1	—	= 1	1	—	= 1	—	—	= —	2	—	= 2	2	—	= 2
——	1	—	= 1	1	1	= 2	4	—	= 4	—	—	= —	5	1	= 6	6	1	= 7
Per cent. of cases	100·0	—	=100·0	12·5	100·0	= 22·2	57·1	—	= 57·1	—	—	= —	33·3	100·0	= 37·5	37·5	100·0	= 41·2
1880	—	—	= —	1	—	= 1	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1
1881	—	—	= —	2	—	= 2	3	—	= 3	—	—	= —	5	—	= 5	5	—	= 5
1882	—	—	= —	4	—	= 4	—	—	= —	—	—	= —	4	—	= 4	4	—	= 4
1883	—	—	= —	3	—	= 3	1	—	= 1	—	—	= —	4	—	= 4	4	—	= 4
1884	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	—	= —
1885	—	—	= —	2	—	= 2	—	—	= —	1	—	= 1	3	—	= 3	3	—	= 3
1886	—	—	= —	1	—	= 1	1	—	= 1	—	—	= —	2	—	= 2	2	—	= 2
1887	—	—	= —	—	—	= —	2	—	= 2	1	—	= 1	3	—	= 3	3	—	= 3
——	—	—	= —	13	—	= 13	7	—	= 7	2	—	= 2	22	—	= 22	22	—	= 22
Per cent. of cases	—	—	= —	35·1	—	= 34·2	50·0	—	= 50·0	50·0	—	= 50·0	40·0	—	= 39·3	38·6	—	= 34·9

TABLE XII.—*continued.*

——	0-			15-			45-			65 upwards.			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	1	= 1	—	—	= —	—	—	= —	—	—	= —	—	—	= —	—	1	= 1
1881	—	—	= —	3	—	= 3	—	—	= —	—	—	= —	3	—	= 3	3	—	= 3
1882	1	—	= 1	3	—	= 3	—	—	= —	—	—	= —	3	—	= 3	4	—	= 4
1883	—	—	= —	1	—	= 1	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1
1884	—	—	= —	1	—	= 1	—	—	= —	—	—	= —	1	—	= 1	1	—	= 1
1885	—	—	= —	—	—	= —	—	1	= 1	—	—	= —	—	1	= 1	—	1	= 1
1886	—	—	= —	—	—	= —	2	—	= 2	—	—	= —	2	—	= 2	2	—	= 2
1887	—	—	= —	3	—	= 3	1	—	= 1	—	—	= —	4	—	= 4	4	—	= 4
——	1	1	= 2	11	—	= 11	3	1	= 4	—	—	= —	14	1	= 15	15	2	= 17
Per cent. of cases	25·0	100·0	= 40·0	50·0	—	= 39·3	42·8	100·0	= 50·0	—	—	= —	46·7	14·3	= 40·5	44·1	25·0	= 40·5
Total whole period of 8 years.	2	1	= 3	25	1	= 26	14	1	= 15	2	—	= 2	41	2	= 43	43	3	= 46

TOTAL DEATHS each YEAR.

——	0-			15 upwards.			All Ages.		
	M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
1880	—	1	= 1	1	—	= 1	1	1	= 2
1881	—	—	= —	9	1	= 10	9	1	= 10
1882	1	—	= 1	7	—	= 7	8	—	= 8
1883	—	—	= —	6	—	= 6	6	—	= 6
1884	—	—	= —	1	—	= 1	1	—	= 1
1885	—	—	= —	4	1	= 5	4	1	= 5
1886	1	—	= 1	4	—	= 4	5	—	= 5
1887	—	—	= —	9	—	= 9	9	—	= 9
Total whole 8 years	2	1	= 3	41	2	= 43	43	3	= 46
Whole year 1888									

DEATHS PER CENT. of CASES.

0-			15 upwards.			All Ages.		
M.	F.	M.F.	M.	F.	M.F.	M.	F.	M.F.
—	100·0	=100·0	11·1	—	= 10·0	11·1	50·0	= 18·2
—	—	= —	50·0	50·0	= 50·0	50·0	50·0	= 50·0
100·0	—	=100·0	58·3	—	= 53·8	61·5	—	= 57·1
—	—	= —	33·3	—	= 33·3	33·3	—	= 33·3
—	—	= —	16·6	—	= 14·3	16·6	—	= 12·5
—	—	= —	44·4	100·0	= 50·0	30·8	33·3	= 31·2
50·0	—	= 25·0	44·4	—	= 40·0	45·5	—	= 35·7
—	—	= —	47·4	—	= 42·9	47·4	—	= 42·9
28·6	16·7	= 23·0	41·0	22·2	= 39·4	40·1	20·0	= 37·7
—	—	= —	43·6	50·0	= 43·9	43·5	40·0	= 43·3

On Pleuro-pneumonic Fever in Middlesbrough and neighbourhood; by Dr. Ballard.

Table XIII.

Showing the Cases of Pneumonia treated in the Union Workhouse from 1880 to 1887, distinguishing Inmates, Sex, and Age.

[The list was made for us by Mr. Bray, the master, from the medical registers at the workhouse.]

Inmates.	Date.	Sex.	Age.	Result.
	1880.			
I.	January 4	M.	43	D.
I.	„ 9	M.	64	R.
I.	„ 10	M.	6	D.
	„ 11	M.	52	R.
I.	„ 31	F.	12	R.
	February 27	M.	30	D.
	March 6	M.	53	R.
	„ 15	M.	40	R.
	„ 18	M.	78	R.
	„ 30	M.	40	R.
	„ 30	M.	28	R.
I.	April 11	M.	15	R.
I.	„ 19	M.	12	R.
	May 11	M.	26	R.
I.	June 5	M.	80	R.
	September 27	M.	37	R.
	November 23	F.	3	D.
	„ 30	F.	18	R.
	1881.			
	January 16	F.	27	D.
	„ 23	M.	24	R.
I.	„ 24	M.	7	D.
	„ 29	M.	47	D.
	February 17	M.	54	R.
	March 3	M.	27	D.
	„ 4	F.	33	R.
	„ 16	M.	41	R.
	„ 16	M.	34	R.
	April 19	M.	50	D.
	May 3	M.	56	D.
	„ 14	M.	50	D.
	„ 27	M.	38	D.
	„ 27	M.	49	R.
I.	June 6	F.	14	R.
	July 15	M.	41	R.
	September 27	M.	46	R.
	October 17	M.	44	D.
I.	„ 27	M.	37	R.
	November 4	M.	42	D.
	„ 14	M.	30	R.
	„ 18	M.	16	R.
	„ 28	M.	34	D.
I.	December 17	M.	1½	D.
	1882.			
	January 4	M.	21	R.
I.	„ 4	M.	4	D.
	„ 17	M.	29	R.
	„ 17	M.	50	R.
I.	March 28	M.	61	R.
	April 16	M.	17	D.
	„ 20	M.	20	D.
	May 23	M.	40	D.
	June 24	M.	43	D.
I.	„ 28	M.	6	R.
	August 30	M.	43	D.
I.	October 9	F.	6	R.
	„ 30	M.	11 mos.	D.
	November 8	M.	28	D.
	„ 13	M.	33	R.
I.	„ 24	M.	6	D.
	„ 28	M.	33	D.
	December 5	F.	23	R.
I.	„ 7	M.	45	R.
I.	„ 9	M.	5	R.
	„ 30	M.	38	R.
	1883.			
	January 1	M.	24	R.
	„ 17	M.	60	D.
I.	„ 22	F.	4	R.
I.	February 13	M.	25	D.
I.	„ 14	M.	47	R.
	„ 28	M.	39	R.
	„ 28	M.	46	D.
	March 3	M.	56	R.
	„ 6	M.	31	R.
	„ 9	M.	40	D.
	„ 15	M.	19	R.
	„ 21	M.	43	D.
	April 3	M.	46	R.
	„ 12	M.	23	R.
	May 22	M.	20	R.
	June 5	M.	40	D.
	„ 7	M.	30	R.
I.	„ 12	M.	14	R.
I.	„ 13	M.	10	R.
I.	„ 13	M.	11	R.
I.	„ 15	M.	10	R.
I.	„ 16	M.	7	R.
I.	„ 16	M.	6	R.
I.	„ 19	M.	13	R.
	August 24	M.	40	D.
	„ 24	M.	27	R.
I.	October 20	M.	2	R.
	November 21	M.	49	R.
I.	„ 28	M.	Infant	D.
	December 3	M.	18	R.
	1884.			
	February 25	M.	36	R.
	March 6	F.	10 mos.	R.
	„ 14	M.	20	R.
I.	„ 14	F.	Infant	R.
	June 6	M.	52	R.
	July 17	F.	43	R.
	„ 30	M.	Adult	D.
I.	August 5	M.	74	D.
	„ 21	F.	68	D.
I.	„ 31	M.	2	R.
I.	October 29	F.	8	R.
	December 17	M.	44	D.
I.	„ 23	F.	4	D.
	1885.			
	January 28	M.	48	D.
	February 2	M.	40	D.
I.	March 10	F.	13	R.
	„ 18	F.	7	R.
I.	„ 19	F.	13	R.
	„ 31	M.	28	R.
	April 16	M.	25	R.
I.	April 17	M.	5	R.
	May 6	M.	14	R.
	„ 12	M.	12	D.
	„ 19	M.	6	R.
	June 5	F.	1	R.
I.	„ 10	M.	8	R.
I.	„ 12	M.	11 mos.	D.
	„ 24	M.	33	R.
	„ 29	M.	43	D.
I.	July 2	M.	12	R.
I.	„ 17	M.	11	R.
I.	„ 18	F.	12	R.
I.	„ 20	F.	5	R.
I.	„ 23	F.	13	R.
I.	23	F.	9	R.

TABLE XIII.—*continued.*

Inmates.	Date.	Sex.	Age.	Result.
	1885.			
I.	September 16	M.	13	R.
	„ 23	M.	8	R.
	„ 23	M.	5	R.
I.	October 17 -	M.	70	D.
	„ 29 -	M.	33	D.
	December 8 -	F.	53	D.
I.	„ 12 -	F.	2½	R.
	„ 17 -	M.	56	R.
	1886.			
	January 19 -	M.	8	D.
I.	„ 24 -	M.	19	R.
	„ 27 -	M.	42	R.
I.	„ 30 -	M.	56	D.
I.	„ 31 -	M.	14	R.
I.	February 9 -	M.	48	R.
	„ 14 -	M.	36	R.
	„ 21 -	F.	4	R.
I.	March 2 -	M.	45	D.
I.	„ 5 -	M.	46	R.
	„ 18 -	M.	32	D.
I.	„ 26 -	M.	1½	R.
	April 14 -	M.	47	D.
I.	„ 18 -	M.	11 mos.	D.
I.	„ 22 -	F.	57	D.
	May 12 -	M.	40	R.
	„ 17 -	M.	15	R.
I.	„ 24 -	M.	43	D.
I.	June 7 -	F.	3	R.
I.	„ 26 -	F.	3	D.
	July 4 -	F.	2	R.
I.	August 6 -	F.	40	R.
	September 4	F.	31	R.
I.	„ 29	M.	8	R.
I.	October 3 -	M.	85	D.
	„ 8 -	M.	62	D.

Inmates.	Date.	Sex.	Age.	Result.
	1886.			
I.	September 13 -	M.	9	R.
	„ 18 -	M.	1	R.
	„ 21 -	M.	49	D.
	November 24	M.	40	R.
	1887.			
	January 4 -	M.	22	R.
	„ 4 -	M.	45	D.
	„ 10 -	M.	40	D.
	„ 21 -	M.	61	R.
	„ 22 -	M.	40	R.
	February 2 -	M.	23	R.
	„ 15 -	M.	53	R.
	April 20 -	M.	23	R.
I.	„ 28 -	M.	74	D.
	„ 29 -	M.	65	D.
I.	„ 30 -	M.	71	D.
	May 18 -	M.	40	R.
I.	„ 20 -	M.	64	D.
	„ 31 -	M.	48	D.
	June 15 -	M.	56	D.
	„ 27 -	M.	70	R.
	July 19 -	M.	62	D.
I.	„ 27 -	M.	29	R.
I.	September 8	M.	10	R.
	„ 17	M.	60	R.
	October 4 -	F.	28	R.
I.	„ 21 -	F.	3	R.
	November 9	M.	39	D.
	„ 18	M.	31	D.
I.	December 8	F.	9	R.
I.	„ 22	F.	4	R.
	„ 22	F.	19	R.
	„ 24	M.	38	D.
	„ 28	M.	37	R.
I.	„ 31	M.	71	D.

Table XIV.

Showing the Cases of Pneumonia admitted into Cork Street Hospital, Dublin, from 1879 to 1888; showing also how many were Fatal.

—	1879.		1880.		1881.		1882.		1883.		1884.		1885.		1886.		1887.		1888.		Total.		
	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.	Admitted.	Died. No.	Died. %
January	1	0	6	0	2	1	2	0	6	0	7	1	7	1	3	1	2	1	6	0	42	5	11·9
February	1	0	4	2	0	0	5	0	7	0	3	0	5	1	4	1	4	1	3	0	36	5	13·9
March	0	0	6	0	0	0	4	1	13	3	7	1	13	5	5	1	7	4	6	2	61	17	27·9
April	6	2	5	2	5	0	5	0	13	1	9	3	9	4	6	1	8	2	3	1	69	16	23·2
May	4	0	5	1	6	1	5	0	8	0	11	2	9	3	8	2	10	1	6	0	72	10	13·9
June	3	2	0	0	2	0	0	0	11	1	11	4	1	0	4	0	6	0	7	0	45	7	15·5
July	2	0	8	2	8	0	3	0	7	2	10	1	2	0	3	0	5	2	3	3	51	10	19·6
August	2	0	3	3	7	1	2	0	3	0	6	1	3	1	1	0	2	0	1	1	30	7	23·3
September	0	0	3	0	2	0	2	0	2	0	7	2	5	1	0	0	4	1	3	0	28	4	14·3
October	2	0	0	0	1	0	4	0	5	1	6	1	13	2	4	0	6	1	8	0	49	5	10·2
November	4	0	2	0	4	0	4	0	6	1	8	1	4	0	4	0	8	1	3	0	47	3	6·4
December	4	2	3	1	1	0	3	0	10	1	8	2	5	0	5	0	5	1	3	1	47	8	17·0
Total	29	6	45	11	38	3	39	1	91	10	93	19	76	18	47	6	67	15	52	8	577	97	—
Deaths %	—	20·7	—	24·4	—	7·9	—	2·6	—	11·0	—	20·4	—	23·7	—	12·8	—	22·4	—	15·4	—	—	16·8

Table XV.

Instances of Multiple Cases in a House, particulars of which were obtained.

Date of Attack or First Medical Attendance.	Residence.	Name.	Age.	Occupation.	Result and Date of Death or Convalescence.	Medical Attendant.	Remarks.
1.			Years.				
October 20, 1887	21, Norton Street	John Bedford	3		Recovered	Dr. Ketchen	—
November 10, 1887	„	Alice „	8		„	„	Attacked while brother John was recovering, and three weeks after him.
November 22, „	„	Lizzie „	10		„	„	Attacked on 13th day of Alice's illness.
2.							
November 6, 1887	2, Wray's Yard, Mason Street.	John Daly	21	Labourer	Recovered Nov. 20.	Dr. Bateman	—
January 27, 1888	„ „	William Daly	50	„	Recovered Feb. 14.	„	Attacked nearly three months after his son John.
3.							
November 7, 1887	10, Mason Street	John Lahey	19	Labourer	Recovered	Dr. Bateman.	Sent to fever hospital on suspicion of enteric fever.
November 7, „	„ „	Margaret Lahey (John's sister).	9		„	„	—
April 23, 1888	„ „	Ann Connor	60	Pauper	Died April 28	„	Attacked about six months later than above.
4.							
November 14, 1887	100, Spencer Street	Margaret Clark	35	Housewife	Recovered	Dr. Malcomson	Was "housekeeper" to P. Cunningham's father. She had left before Peter C. was taken ill.
March 6, 1888	„ „	Peter Cunningham	14	Son of a labourer	„	„	Attacked nearly four months later than Mrs. Clark.
March 5, „	„ „	Henry „	38	Labourer (Peter's uncle).	Died [Infirmary] Mar. 9.	Dr. Hinshelwood.	Peter and Henry taken ill nearly together.

TABLE XV.—*continued.*

Date of Attack or First Medical Attendance.	Residence.	Name.	Age.	Occupation.	Result and Date of Death or Convalescence.	Medical Attendant.	Remarks.
5.							
November 11, 1887	10, Mineral Street	Patrick Hyam	23		Recovered Dec. 3.	Mr. Longbotham.	—
December 21, „	„ „	Joseph „ (brother)	16		Recovered	„	Attacked about six weeks later than his brother.
6.							
January, 1888	Grange Town	P. McHale	50	Blast-furnace-man	Recovered	Dr. Riordon	The dates of attack are not given, but both were in January. Dr. R. gave me list of 15 houses in which he had attended cases, but this was the only house in which more than a single case occurred under his observation.
January, „	(Same house)	L. „ (his son)	19	„ „	„	„	
7.							
January 24, 1888	1, Hudson Street (common lodging house).	Thomas Harrington	Adult		Recovered	?	Slept in No. 2 room, but when ill removed to landlady's sitting room.
?	„ „	James Fall	„		„	Dr. Cook	Slept in No. 3 room, but when ill removed to landlady's sitting room.
March 5, 1888	„ „	William Mack	40		Died March 7	Mr. Longbotham.	Slept in No. 1. room, but when ill removed to landlady's room. There was only one other lodger in the house, and neither he nor landlady were taken ill.
8.							
February 2, 1888	25 Garden Street	— Martin	12	School boy	Recovered	Dr. Bateman.	—
February 18, „	„ „	— „ (his brother)	14		„	„	Attacked on 17th day of his brother's illness.
February 29, „	„ „	Patrick Healey	14		„	Mr. Longbotham.	„ 12th „ illness of 2nd case.
June 6, „	„ „	— Healey (his brother)	5		„	„	„ three months later than his brother Patrick. This was an over-crowded house. Mr. Longbotham says there was a third case before P. Healey, but it cannot be traced.

TABLE XV.—*continued.*

Date of Attack or First Medical Attendance.	Residence.	Name.	Age.	Occupation.	Result and Date of Death or Convalescence.	Medical Attendant.	Remarks.
9.							
February 7, 1888	5, Thompson Street	Mrs. Mallinson	60	Housewife	Recovered	Dr. Bateman.	—
February 9, „	„ „	Niece of above	6	- - -	„	„	Attacked on third day of her aunt's illness.
10.							
February, 1888	11, Newcastle Row	M. Keegan	42	Labourer	Died Feb. 15, 1888.	Dr. Craster.	—
February 14, „	„ „	Catherine Keegan	38	Pauper (his wife)	Recovered	Dr. Bateman	The dead husband was being "waked" when Dr. Bateman was called to these cases, and the house was crowded with neighbours. They were attacked before M. Keegan died.
February 14, „	„ „	Her daughter	12	- - -	„	„	
11.							
February 19, 1888	14, Newcastle Row	Margaret Keegan	28	Pauper	Recovered April.	Dr. Bateman	Recovery slow. Abscess formed in upper lobe of one lung.
April 6, 1888	„ „	John Croftdale	47	Labourer	Died April 9	„	He occupied lower part of house. His wife nursed him and Margaret Keegan, but was not attacked.
April „	„ „	A child of Croftdale's	?	- - -	Recovered	„	Taken ill soon after her father's death.
12.							
February 1888	16, Newcastle Row	— Carr (sister of Margaret Keegan).	18	- - -	Died Feb. 27	Dr. Craster.	—
May 11, „	„ „	Bernard Carr (father of above).	67	Pauper	Died May 17	Dr. Bateman	Attacked nearly three months after his daughter.
13.							
February 17, 1888	123, Linthorpe Rd.	Samuel Leybourne	58	- - -	Died Feb. 23	Dr. Young.	—
February 25, „	„ „	His wife	56	- - -	Died March 29	„	Attacked on ninth day of her husband's illness. Was recovering, but died from "apoplexy."

TABLE XV.—*continued.*

Date of Attack or First Medical Attendance.	Residence.	Name.	Age.	Occupation.	Result and Date of Death or Convalescence.	Medical Attendant.	Remarks.
14.							
March 1888	22, Elm Street	F. W. Fosdick	34		Died March 9	Dr. McCraig.	Attacked two months after Fosdick's death. The Fosdick family quitted this house on March 19, and a new family entered with this man as a lodger on March 23. At end of April they left, and another family took possession on June 11. None of this last family were attacked. Unwholesome condition of premises.
May 1, „	„ „	Martin Ludelm	60		Recovered May 26.		
15.							
March 4, 1888	10, Durham Street, common lodging-house.	David Smith	46	Labourer	Died in workhouse Mar. 11.		Slept in first floor back room (resident here for seven years). Removed to workhouse infirmary March 8.
March 8 or 9, 1888	„ „	Thomas Witham	36	„	Recovered		Slept in same bed with Smith until Smith was taken ill, and then in same room with him in another bed. Removed to Cottage Hospital March 10.
March 8 or 9, „	„ „	William Owen	32	„	„		Slept in first floor front room nearest landing. Removed to North Riding Infirmary March 10.
March 17, 1888	„ „	Thomas Carey	37	„	Died March 25		Slept in same room as W. Owen. Removed to North Riding Infirmary March 20.
March 17, „	„ „	Henry Whitley	60	„	Died March 23	Mr. Longbotham.	Slept in front attic.
March 19, „	„ „	Mrs. Burns	about 50	The lodging-house keeper.	Recovered	„	Slept in back ground-floor room at rear of a shop.
March 25, „	„ „	George Gallon	26	Labourer	„		Slept in same room at Thomas Carey. Removed to Cottage Hospital March 27.
April 30, „	„ „ [Few casual lodgers taken in. Those attacked were habitual lodgers.]	Benjamin Williamson	45		Died May 3	Mr. Longbotham.	Slept in same room that Smith and Witham had occupied. No one else slept there at that time.

TABLE XV.—*continued.*

Date of Attack or First Medical Attendance.	Residence.	Name.	Age.	Occupation.	Result and Date of Death or Convalescence.	Medical Attendant.	Remarks.
16.							
March 4, 1888	15, Lawson Street	Michael Collins	8	Schoolboy, son of a labourer.	Recovered March 31.	Dr. Malcomson.	—
March 17, „	„ „	Ellen Collins (sister)	14		Recovered	„	Attacked about 14th day of her brother's illness.
March 28, „	„ „	Michael Levin (lodger)	60	Labourer	Died April 4	„	Attacked about 12th day of Ellen's illness and 25th day of Michael's.
17.							
March 16, 1888	3, Sun Street	J. Kelly	39		Died March 20	Dr. Craster.	—
March 21, „	„ „	His wife	40		Recovered	„	Attended on and nursed her husband; attacked sixth day of husband's illness.
18.							
March 24, 1888	5, Cross Street	Arthur Banting	66	Pauper	Recovered	Dr. Bateman.	— —
March 31, „	„ „	Bridget Banting (his wife).	65		Died April 11	„	Attacked on eighth day of husband's illness.
19.							
March 29, 1888	10, Marsh Street	— Henry	16	Labourer	Recovered	Dr. Veitch	Slept in same room with his father and mother
April 14, „	„ „	— Henry (father of above).	52	„	Died April 30	„	Attacked on 17th day of son's illness.
20.							
April 1, 1888	20, Princes Street	Thomas Black	60	Rag gatherer	Recovered	Dr. Bateman.	—
April 9, „	„ „	James Scott (lodger)	26	Pauper	Died April 15	„	Attacked ninth day of Black's illness. Assisted in nursing him. Removed to workhouse infirmary.
April 16, „	„ „	Ellen Black	53	Wife of Thomas Black.	Recovered	„	Attacked 16th day of Black's illness. Nursed her husband.

TABLE XV.—*continued.*

Date of Attack or First Medical Attendance.	Residence.	Name.	Age.	Occupation.	Result and Date of Death or Convalescence.	Medical Attendant.	Remarks.
21.							
April, 1888	16, Albert Mews	J. Monty	55		Died April 19	Dr. Andson.	—
April 25, „	„	James Monty	6		Recovered	Mr. Longbotham.	Attacked six days after his father's death.
22.							
May 3, 1888	62, Church Street, North Ormesby.	Mary Bennett	81		Died May 11	Dr. Knott.	—
May 14, „	„ „	Rosina Holt	59		Died May 19	„	Nursed Bennett during her whole illness. Attacked three days after her death.
23.							
May 5, 1888	45, Bolckow Street	The female children named Dean.	12 6 2	Daughters of a mechanic.	Recovered „ „	Dr. Veitch „ „	These children appear to have been attacked almost simultaneously, the eldest perhaps (Dr. Veitch says) two days before the others.
24.							
May 8, 1888	51, Gauntlet Street	Bernard Ruddy	8	Schoolboy	Recovered May 21.	Dr. Malcomson.	—
May 10, „	„ „	Peter Ruddy (his brother).	14	„	Recovered	„	Attacked about third day of his brother's illness.
25.							
May 14, 1888	Mandale Mill, in outskirts of Stockton.	Thomas Burton	27	Schoolmaster	Recovered	Dr. Hind.	—
May 20, „	„ „	Mrs. Burton	50	Wife of miller	„	„	Attacked on seventh day of son's illness.
May 21, „	„ „	Frederick Burton	19	Iron worker (apprentice).	„	„	„ eighth „ brother's illness.

[For further remarks, see p. .]

Table XV.—*continued.*

Date of Attack or First Medical Attendance.	Residence.	Name.	Age.	Occupation.	Result and Date of Death or Convalescence.	Medical Attendant.	Remarks.
26.							
May 19, 1888	55, Vaughan Street	George Walton	56	Millwright	Died, May 26	Dr. Williams.	—
June 2, „	„ „	— Reynolds (lodger)	50	Labourer	Recovered	Dr. Veitch	Attacked seven days after Walton's death.
27.							
May 11, 1888	21, Dundas Mews	Christopher Newby	13		Recovered	Mr. Longbotham.	—
May 21, „	„ „	Anne Marshall	66		Died, May 24	„ „	—
May 30, „	„ „	— Newby (sister of Christopher).	11		Recovered	„ „	—
28.							
May 22, 1888	117, Duncombe St.	James Quincey	10	Schoolboy	Recovered	Dr. Malcomson	It is not stated whether they were both attacked the same day.
May „	„ „	Bridget Quincey	12		„	„ „	
29.							
May 27, 1883	40, Grange Road, West.	Richard Se v	18	School teacher	Died, May 30	Dr. Ketchen.	—
May 30, „	„ „	Mrs. Severs (his mother).	51		„ June 6	„ „	She attended upon and nursed her son; attacked fourth day of son's illness.

ADDENDUM A.

Cases of Epidemic Pneumonia.

Case I.—James Hayes, aged 72 years, an inmate of the Middlesbro' Workhouse, was taken ill with pneumonia on June 13th. He had not been outside the building since May 14th. He was in No. 9 ward when taken ill and was then removed to No. 1 ward of the infirmary, where he died at 3.30 p.m. on June 17th. *Duration* of illness four days. No clinical history of case obtainable.

Autopsy.—June 18th, 11.30 a.m,, 20 hours after death. [This was the first post-mortem that had been made by anyone during the course of the epidemic.]

General condition of body, spare. Rigor mortis; marked post-mortem lividity over posterior and lateral parts of trunk and limbs.

Chest.—Pericardium contained 1 oz. of turbid fluid; a little recent lymph on posterior surface of left ventricle of heart and corresponding surface of pericardium. *Heart.*—Large fibrinous clot moulded into right auricle; similar clot in right ventricle and adhering pretty firmly to the muscular columns and extending into the pulmonary artery. Left ventricle contained similarly a very firm clot of fibrine which was firmly attached to the muscular columns. Heart enlarged, dilated with thickened walls; cartilaginous thickening of attached part of semilunar valves. *Left pleura* contained about 1 oz. of turbid fluid, and there were some old adhesions of the left lung at the base posteriorly. *Right pleura* contained about 7 ozs. of a bloody fluid, and there were some old adhesions at the apex of right lung and to the diaphragm at the base: a considerable quantity of fresh lymph on both surfaces of the pleura on this side. *Left lung.*—Cartilaginous-looking granulations size of pin's head scattered over all the pleural surface. Upper lobe flaccid, lower lobe less so. Surface generally dark purple colour. Section of upper lobe dark reddish brown; crepitated imperfectly; frothy fluid issued on pressure. Lower lobe section dark purple; did not crepitate; an abundance of non-frothy fluid issued on pressure. Pea-sized spots of apparently hæmorrhagic character. Bronchi contained little mucus, but surface stained red; ridges thickened. *Right lung.*—A few little cartilaginous granulations on pleural surface. Upper lobe flaccid and of purple colour; middle lobe full and firm, as also was lower lobe. Fresh lymph on surface of both these lobes and in fissure between them. Upper lobe: section dry; tissue tough; crepitates imperfectly; some hæmorrhagic looking spots; middle lobe pale and mottled with purple streaks and spots; opaque, greyish, frothy fluid issued on pressure. Lower lobe perfectly solid and non-crepitant; similar reddish-grey fluid, but less frothy, issued on pressure. All cut surface pale, but at base much mottled with purple streaks and spots and with grey spots; breaks down readily under pressure. Bronchial tubes contained more fluid than on right side, not frothy, and of opaque, reddish colour; mucous membrane and tissue the same as on right side.

Abdomen.—Liver smooth; section nutmeg; tissue friable. Gall-bladder empty. *Spleen* of normal size, with little cartilaginous-looking granulations on peritoneal surface. No blood issued on section: the surface of maroon colour; substance pulpy. *Kidneys.*—Left kidney: Capsule stripped off readily without bringing any tissue with it; surface indented in places with opaque cicatrix-like depressions. Surface pale. Section pale, little fluid exudes, otherwise organ not obviously diseased. Right kidney much the same as left. *Stomach* contained some lumps of coagulated milk: at posterior surface over a patch 4 or 5 inches square, deep-coloured ecchymosis, the spots running here and there into little hæmorrhagic patches. Some grey mucus adhering everywhere to mucous surface. In most parts mucous membrane uniformly reddened and softened. Intestinal canal healthy, except that about 12 inches above the sigmoid flexure there were some patches of uniform redness, one of them with some small ecchymoses in it.

App. A. No. 18.

On Pleuro-pneumonic Fever in Middlesbrough and neighbourhood; by Dr. Ballard.

Weight of Organs.—Left lung, 26 ozs. Right lung, 60 ozs. Heart, 14¾ ozs. Liver, 4 lbs. Spleen, 4¼ ozs. Left kidney, 6 ozs. Right kidney, 5 ozs.

Case II.—William Young, aged 65 years, an inmate of the workhouse, was taken ill with pneumonia on June 14th. He was in the habit of going out into the town every day with wood. He, like James Hayes, was taken ill in No. 9 ward and was removed at once to No. 1 ward of infirmary, where he died at 1 a.m. on June 17th. Duration of illness, 3 days. No clinical history of case obtainable.

Autopsy at 1 p.m., June 18, 12 hours after death. Post-mortem rigidity well marked. Moderate post-mortem lividity posterially and laterally.

Chest.—Pericardium contained a few drachms of reddish fluid; no lymph effused. *Heart.*— Right ventricle contained a fibrinous clot moulded into its irregularities; it extended into the pulmonary artery. Left ventricle contained a similar fibrinous clot similarly moulded, and adherent among the papillary irregularities and extending into the aorta. Heart of normal size: healthy except some thickening of free borders of mitral valves and attached borders of aortic valves. *Right pleura.*—Old adhesions in most parts, cavity contained about 1 oz. of a reddish fluid. *Left pleura.*—Some old adhesions on base of lung to diaphragm. Fresh lymph in considerable quantity over most of surface, chiefly at lower parts and about base of lung and diaphragm. The cavity contained about 12 ozs. of reddish fluid. *Right lung.*—Recent adhesions between the lobes, and some recent lymph over lower surface of lower lobe. Upper lobe purple on surface; some emphysema at apex; colour of section dark purple; tissue very tough; lower and posterior parts non-crepitant, and exuding an abundance of red, non-frothy fluid on pressure. Middle lobe practically the same. Lower lobe solid, similar colour, more brittle, and exuding same kind of fluid on pressure. Bronchial tubes contained a little frothy fluid; mucous membrane somewhat reddened; otherwise normal. *Left lung.*—Thick layer of soft lymph over most of the surface, and between the lobes. Upper border of upper lobe emphysematous. Lower lobe dark purple, and felt solid—conditions observed also at lower part of upper lobe. On section: Upper part of upper lobe dry, lower part of it non-crepitant, tough, and exuded non-frothy fluid on pressure. Lower lobe on section, tissue firm, and exuded on pressure a very little reddish-grey non-frothy fluid. Bronchial tubes reddened in patches, and contained a little opaque, reddish, non-frothy fluid. Surface of bronchial tubes fairly smooth for the man's age.

Abdomen.—Liver.—Surface smooth, tint normal; section uniformly reddish brown; blood runs out of vessels of cut surface; tissue very friable. *Spleen* small, of deep purple colour, and pulpy, the tissue breaking down on the least pressure. *Kidneys.*—Left kidney apparently normal; capsule stripped off readily; right kidney similar, except that there was a small cyst on surface at lower end, and that at this end the section was redder than in other parts, with some punctiform bleeding points. Bladder contained about 1½ oz. of urine. *Stomach* contained some liquid food; very extensive ecchymosis in some places, running into patches at upper part of cardiac end, and extending along the small curvature. Mucous membrane of part of large curvature had a thickened and mammillated appearance; rest of membrane, and, towards pyloric end, smooth. Intestines normal. *Weight of organs.*—Left lung, 26½ ozs. Right lung, 34 ozs. Heart, 11¼ ozs. Liver, 3 lbs. 1 oz. Spleen, 2 ozs. Right kidney, 3¾ ozs. Left kidney, 3¼ ozs.

Case III.—Jane Roxborough, aged 64 years, a laundress, unmarried, in receipt of poor-law relief, and of intemperate habits. On June 13, being then in her customary health, went to Grange Town to nurse a Mrs. Bowen, who was under treatment for pneumonia by Dr. Blakely, of Grange Town, and who subsequently died of the disease on July 1. She had tippled as usual while at Grange Town. While there she had complained to Dr. Blakely of pain in her side, for which he gave her some medicine. On June 16 she, not feeling well, returned home to Middlesbrough, but had no medical attendance, and the woman with whom she lodged

was the only person that could tell anything about her. She went home on a Saturday afternoon, is not known to have vomited, or to have had diarrhœa, and no coughing was noticed. Mrs. Brown, her landlady, says she stayed with her all day Sunday, but left her when night came on. When she again went into her room, at 5 a.m. on 18th, she found her dead. The coroner ordered an examination of the body, which was made by Mr. Nixon on the morning of 18th, just before the inquest, and completed before I knew anything of the matter. Mr. Nixon, however, was good enough to re-open the body for my inspection. Rigor mortis was marked, and there was lividity of posterior and lateral part of trunk. The lower lobes of both *lungs* were of a deep red colour, but not hepatised. The section exuded, on pressure, much red, turbid, slightly frothy fluid. There was recent lymph in places on *pleural* surface of both lungs. *Heart*, normal; left cavities empty, but a fibrinous firm clod moulded into right auricle and ventricle. *Spleen* small, and almost pulpy in consistence. *Kidneys*, capsules, on being stripped off, brought away portions of the tissue; section pale. *Liver*.—Smooth on surface, exuding a good deal of blood on section; tissue a little softened. Gall bladder full. *Stomach* empty. Hæmorrhagic spots about small curvature. This was necessarily a very hurried examination.

Case IV.—George W. Ward, aged 28 years, a wholesale greengrocer, in the habit of driving about to seek orders. On Sunday, June 15, drove his wife to Redcar for a holiday; he had a greatcoat on, and, although it was cold, he says he did not feel the cold unusually. On night of 18th, being then in his usual health, he went to a performance at a music-hall, and while there felt ill, cold and shivery, so that he left before the end of the performance. He felt as if he had been drinking, and says he could not see where we went; it was as if a sheet of paper were before his eyes. A friend found him wandering about the docks instead of going homewards, and finding he was ill, and not knowing where he was going, took him home. All this time he was shivering. His feet were put into hot water with mustard, and after that he says he felt warmer. Shortly afterwards Dr. Malcomson saw him and found his temperature 104°, and his pulse over 100. He had vomited, and the vomited matter contained a little blood. He said he had been purged three times in the course of the day before he began to feel ill. He was complaining also of pain about the left hypochondrium and about the epigastric region. He said he had had a trifling cough for a long time, which he regarded as due to a cold, and there was no more cough than that when he was visited. Dr. Malcomson gave him a dose of opium and quinine. On the 19th I saw him. His wife told me he had shivered and sweated during the night, slept very little, and had talked wildly. He had also vomited several times, but she had seen no blood in the vomited matters. He has no recollection of having seen the doctor last night. Feels better this morning. Temp. 100°; resp. 15; pulse reduced in frequency. No dulness posteriorly, but some defective breath sounds. A little crepitation on first deep breath over left scapular region, and breath sounds a little exaggerated over right upper back. No cardiac friction. 20th.—Slight delirium last night, had rigors again and pain in stomach and right hypochondrium. Slept well. There has been much vomiting, but no blood. Bowels have not acted. Temp. 99·6°; pulse 88; resp. 16. No abdominal swelling or rash. 23rd.—Bowels acted from an aperient given him on evening of 20th; vomiting has continued, with severe headache and some delirium each night. On 21st some leeches put on his side relieved the pain. On evening of 22nd had a profuse epistaxis which was not interfered with, subsequently his temperature fell to 99°, resp. quiet. Scanty expectoration not markedly rusty. I did not see him again, but he got quite well ultimately. This was a mild attack, although commencing with serious disturbance of the system.

Case V.—Mr. Geal, aged 40, works upon the river, his duty being to see to the mooring of vessels; is out of doors for this purpose at all hours, and is much exposed to cold at his work. Dr. Currie took me to see him on June 19. He is a strongly-built man, much tanned by exposure, and in

the habit of drinking more than is good for him. He sent for Dr. Currie early in the morning of Monday, June 11, having been very ill all the Sunday night. In fact he says he had not been feeling very well all the previous week, but was quite able to go to his work. Dr. Currie stated that he found him hoarse, as if from some laryngitis, and gave him an antimonial emetic, put four leeches on the top of sternum, and subsequently a blister, which relieved this symptom. He had cough with pain across the back reaching to the epigastrium in front. When I saw him his cheeks were flushed; there was cough, with rusty expectoration, but he spoke cheerfully. Temperature 101½°, pulse 98, resp. 60. Dulness over most of right back and at lower part of left back. Friction over right scapular region. Respiratory sounds defective over all dull parts. No cardiac friction sounds. Conjunctivæ yellow (they were not so before illness), urine stained with bile, no albumen in it to-day, and it had not been tested previously. I did not see the case again. The man recovered. There was no history of exposure to infection.

Case VI.—Benjamin Priestley, æt. 39 years, a painter, working at the docks. Went to work as usual and in his usual health on June 18, but in the evening came home with pain across lower part of chest and epigastrium, passed a bad night and felt so ill on the morning of the 19th that he sent for Dr. Malcomson. He had been purged, it seems, on the 18th. I saw him with Dr. Malcomson on the 20th, the third day of his illness. He had taken two eggs but had vomited them; there was no blood in the vomited matter. I found him lying in a state of extreme prostration, moaning, and with a distressed countenance; tongue brown and dryish, but white at the edges. Temp. 101·8°, pulse 120, extremely weak, resp. 44. Has had some delirium. Passed urine last night unconsciously into bed. He was so weak that it was not safe to raise him in bed for physical examination. A rapid examination on turning him on his side, however, showed dulness on percussion in both backs, with tubular breathing in left back; the right back could not be examined. I did not see him again. He died on June 21 at 9 a.m., after an illness of about 2½ days.

Autopsy.—Made by Dr. Malcomson and Dr. Klein at 4.30 p.m., *i.e.*, 7½ hours after death. The body was still warm, rigor mortis had scarcely commenced, and there was no post-mortem lividity. The examination was made hurriedly in consequence of the noisy opposition of neighbours. It was only made at all through police assistance. The pericardium contained scarcely any fluid. Heart was not opened, but Dr. Klein drew what he needed of its contents from the cavities; he could get nothing but serum from them. Both pleuræ were almost everywhere adherent. (Dr. Malcomson had attended him two years previously for a pleuro-pneumonic attack.) *Lungs* brittle and tore in the act of taking them out. Both were solidified in posterior part of lower lobes. Anterior edges spongy. Fluid ran in streams from the cut surface. *Liver* looked healthy. *Spleen* appeared somewhat enlarged, but it was firm and healthy looking. *Kidneys* were not examined.

Case VII.—Mary Ann Rigg, æt. 68 years. On Saturday, June 16th, was seized with rigors and has been shivering occasionally since. Still she kept about the house until the night of Monday, the 18th, when she felt so ill and tired that she went to bed and could not get up the next morning. On the Saturday night says she took some "castor-oil pills," which acted on her bowels. I saw her with Dr. Malcomson on June 20th (the fifth day of illness). She had not vomited, but felt sick. Wandered in her mind yesterday. Has pain in left side, but not acute; some cough. Tongue not furred, but a little dry in the centre. Temp. 103°, pulse 100, resp. 24. Dullness over right back, with harsh breath sounds. She was strong enough to sit up in bed for physical examination. No crepitant râles. I did not see her again. She died on June 25th, the tenth day of illness.

Autopsy, made by Dr. Malcomson 1½ hours after death. Body still warm. *Right pleura*, covered with recent lymph, but not abundantly; about 3 ozs. of fluid in the pleural cavity. *Left pleura* smooth and healthy.

Right lung consolidated throughout; friable; dirty-brown, frothy fluid exuded from rents made in turning it out. *Left lung* light, spongy, and crepitant. Heart firmly contracted; all the cavities almost empty; no coagula; only just a little fluid blood; valves healthy. *Spleen* small, firm, and consistent; on section dry and nothing exuded on firm pressure. A portion of the fresh lung was at once forwarded to Dr. Klein.

Case VIII.—E. Skinner, æt 44 years, a costermonger, small retail dealer, and milkseller. A teetotaller for the last 15 years, but previously to that was a hard drinker. Was taken ill on the evening of Sunday, June 17th, with shivering, and had diarrhœa during the night. Had been well all the day, and had only had some codfish for his dinner in the middle of the day. Was first seen by Dr. Ketchen in the forenoon of June 18th; his pulse was then 120 and resp. 24. Yesterday, June 19th, his pulse was 130 and temp. 105°. There was dullness over the right base posteriorly, bronchial breathing in one part, and fine crepitation in another part, cough, and expectoration of non-bloody tenacious mucus. He had diarrhœa and there was albumen in his urine. I saw him with Dr. Ketchen at 11 a.m. on 20th. He had had no sleep; looks ill and flushed in the face. Was a little delirious this morning. Has a good deal of cough, which he says pains him all round his right side; no pain on left side. Sputa tenacious with some rusty streaks. Says he vomited on morning of 18th. There is dulness on percussion all round the back, with tubular breathing and some crepitation at the base; pulse 130; resp. 30; temp. 104·6°. I did not see him again. He ultimately recovered.

Case IX.—Mrs. Skinner, æt 48 years, the wife of the above; a large well-nourished woman; slept in same bed with her husband. Began to be ill on the evening of Monday, June 18th. She felt giddy on the Tuesday morning, "could not stand and felt loaded at her chest," and was found ill in bed with her husband when Dr. Ketchen visited him on June 19th. She complained then of pain in her left side; temp. 105°; pulse 120. There was some albumen in her urine; but there were at that time, Dr. Ketchen says, no physical signs of pneumonia. I saw her with Dr. Ketchen on Wednesday, 20th. She said she had been a teetotaller for 13 years. She had vomited in the course of the morning. Her face was flushed, tongue brown with white edges and dry. There was very little cough, but what there was caused her to "catch her breath." A good deal of headache. No action of bowels. Temperature 104·2; pulse 124; resp. 25. I did not see her again. She ultimately recovered.

Case X.—Hanlon, a powerfully-built man, apparently about 26 years of age; a labourer with no fixed dwelling, came to the "model lodging-house," South Bank at 7.30 p.m., June 23rd, ill, and was seen by Dr. Glen. He was complaining of fatigue, and went to bed immediately. He had been at the lodging-house about a week before, but for the intervening time had been in Middlesbrough (I could not discover where in the town), and had been drinking all the week. There were no vomiting, diarrhœa, or epistaxis during the 24th. He died that day at 5.30 p.m.

Autopsy, made June 25th, at 11 a.m., 17½ hours after death. Rigor mortis perfect. Deep lividity of posterior and lateral parts of trunk and limbs.

Chest.—Pericardium contained about 1 oz. of clear serum. A small old patch of firm lymph, about size of a sixpenny-piece, on anterior surface of heart. *Heart.*—Fluid blood ran from all the cavities of the heart and large vessels proceeding from it, on removing the organ Right ventricle also contained a small quantity of fibrinous coagulum; left ventricle contained no coagulum. Walls and valves healthy. *Pleuræ.*—A little old adhesion of right lung posteriorly. Left lung not adherent. No evidence of pleural inflammation. *Right lung.*—Posterior part of each of the lobes firm and purple coloured; on section found full of blood, and exuded a quantity of red frothy fluid on pressure; non-crepitant. *Left lung* spongy, except a collapsed patch of several inches in extent on lower lobe; this patch was depressed, of deep purple colour on surface,

and on section was tough and non-crepitant, and exuded no fluid on pressure. Bronchial tubes of right lung much reddened, and contained a large quantity of very frothy mucus; they were similarly reddened in left lung, but contained only a little frothy mucus.

Abdomen.—Liver of largish size; section showed nutmeg appearance. Much blood ran out on section. *Stomach* contained a few ounces of liquid food. Redness and ecchymosis (some in distinct spots, some confluent) along the small curvature, especially towards the cardiac end; some also about the large curvature; mucous membrane elsewhere in large rugæ and uniformly reddened; some small mammillation towards the pyloric end. *Left kidney.*—Capsule did not strip off very readily, but brought no issue with it. Section watery, dark coloured; structure coarse looking. *Right kidney* smaller with similar characters, but not quite so coarse looking. *Bladder* greatly distended, 6 inches above pubes. *Spleen* largish and flabby; very soft, almost pulpy, so that a clean section could not be made.

Case XI.—R. Howe, aged 37 years, an iron shearer, of intemperate habits. His father, a blacksmith, was ill with "pneumonia," in the early part of June, and died of the disease on June 9. He did not reside in same house as his son. This man was with his father daily when he was ill, and so was a Mrs. Hardy, a nurse, who has not had an attack. Since the funeral he has been engaged selling his father's goods and drinking freely. On Wednesday, June 20, he worked in the rain and slush, and, having then got wet, put his coat on without changing his clothes, and so remained during the rest of the day. On 21st, at noon, was seized suddenly with rigors and "pain across the kidneys," and also with vomiting; no diarrhœa. Dr. Andson was called to see him, and says he was then "queer in his head," but had violent delirium two days later. When he saw him he had pain in his side. Dr. Andson says he seemed to be going on fairly well when sudden prostration occurred, and he died at 10 p.m. on the 24th (after three days illness). Says his pulse had been 100 to 105 and his temperature 104°.

Autopsy.—June 27, at 11 a.m., 61 hours after death. A strongly-built man; rigor mortis firm. Lividity on back and sides of the trunk.

Chest.—Pericardium contained about 1 oz. of reddish, turbid fluid. *Heart.*—Right ventricle and pulmonary artery contained a fibrinous clot, softer in the ventricle than in the artery; there was no clot on the left side of the heart. *Right pleura* showed firm lymph on surface posteriorly, and between lobes of lung; it contained turbid fluid. *Left pleura* in much the same condition, but the quantity of effused lymph was less. *Right lung.*—Upper lobe firm and red, broke down on pressure, and a very turbid, reddish, opaque fluid ran out; lower lobe dark coloured, and looked hæmorrhagic; on section was firm and tough; some reddish liquid flowed out on pressure. Left lung in similar condition in both lobes to lower lobe of right lung.

Abdomen.—(Condition of liver accidently omitted from notes.) *Spleen.* rather large; flabby, chocolate-coloured on section; broke down on the slightest pressure, being almost pulpy. *Stomach* contained some liquid food; abundant ecchymosis on posterior surface near the small curvature mostly towards the cardiac end, but elsewhere also, more indeed than I had noted in the foregoing cases. In other parts mucous membrane reddened with patches of ecchymosis; in large curvature and pyloric half mucous membrane in rugæ and mammillated. *Duodenum* deeply reddened uniformly, with some patches of deeper red colour which looked hæmorrhagic. *Right kidney* enlarged, very flabby; capsule stripped off with unusual readiness, but brought no tissue with it; upper end mottled with red spots on surface; this mottling elsewhere also, but less marked; tissues so flabby that it was difficult to cut the organ straight through; section exuded much oily matter; pyramids not readily definable, but there was reddening in broken lines all round their margin; rest of tissue pale. *Left kidney* smaller and with similar character to the right kidney.

Case XII.—Mr. Marwood Smith, aged 58 years, a retired sea captain, carrying on a coal business in Middlesbrough, in a comfortable station of life, and residing in a good, well-furnished house. Has all his life been a teetotaller; says he has never tasted grog or any other liquor. On Friday, June 22nd, had a chop and potatoes for his dinner in the middle of the day, and spent his time as usual at his coal office. Usually eats American bacon for breakfast. Was taken ill suddenly at 5 a.m. on Saturday, June 23, with rigors and vomiting; still he went to his office, but had soon to return home and go to bed, the vomiting continuing. Dr. Walker was sent for, and took me to see him on June 27 (the fifth day of illness). He is a spare man, bronzed with exposure to the weather. He had been violently delirious during the morning, and there was difficulty in keeping him in bed. There was dulness on percussion over upper lobe of both lungs posteriorly, marked tubular breathing over right upper lobe posteriorly, and some friction sounds about base of left lung; elsewhere breath sounds harsh. No cardiac friction. Temp. 103° (it has been higher); pulse 100, small; resp. 40. No albumen in urine. I did not see him again. He died at 9.40 a.m. on June 29, after six days' illness. No post-mortem examination was made. On June 20 an old lady, who slept in an adjoining room, was attacked with erysipelas of the head and face. She was convalescing when I saw her on 27th. Two years ago in the same house a lad, aged 14, had a severe attack of enteric fever, but recovered.

The house is situated in Marten Road, through which runs one of the main intercepting storage sewers. There used to be stinks from the neighbouring sewer openings in the road at one time, but these have ceased since some ventilating shafts have been put up. No bad smells in the house have been noticed. The only drain inlet within the house is at the sink in back kitchen, where family mostly sit and take meals. The top of the sink-pipe is not trapped; a stone is placed over it. The sink pipe passes underground to beneath the grating of a gully in the yard, which gully is constructed and trapped as shown on p. . The pantry of the house is immediately behind and opens into this kitchen; its window, open for ventilation, is only a few feet from the door of a covered ash-pit privy, serving this and an adjoining house; the contents of the privy were dry except where excrement lay beneath the seat. Some bacon and a piece of, what I was told, was home-cured Yorkshire ham were hanging in the pantry. I took some of them for examination by Dr. Klein. On July 4, up to which date no one else had been ill in the family, I found that all that I had seen hanging up had been consumed, except a small piece of bacon, which I secured and sent (as a second sample) to Dr. Klein.

Case XIII.—Arthur W. Brison, aged 27 years, a tailor, residing next door to a common lodging-house, No. 10, Durham Street, where there had been several cases of "pneumonia" (see p. ·). On Sunday, June 24, after a mid-day dinner, went by an excursion steamboat to Yarm, and on returning somehow fell into the Tees, was consequently soaked through, and sat in the boat for three hours in his wet clothes. On the Sunday morning he had for breakfast eggs and fried American bacon, which he had bought at X's shop. He had eaten no bacon all the week before. For dinner he had roast beef and Yorkshire pudding. He had no bacon at his breakfast on the following day (Monday). On Monday, 25th, at 6 p.m., was attacked with rigors and coughed; he had no sleep that night. At noon, on the 26th, he vomited, but had no diarrhœa until the night of Wednesday, 27th. Dr. Walker, who was attending him, took me to see him on June 30th (sixth day of illness). Had pain in the left side this morning for the first time; had cough, but no expectoration. Pulse was 125; resp. 60; temp. 104°. There was dulness on percussion over both backs, and tubular breathing almost universally, with some friction sounds. I did not see him again. He died on the morning of July 3rd, or eighth day of illness.

No post-mortem examination made.

App. A. No. 18.

On Pleuro-pneumonic Fever in Middlesbrough and neighbourhood; by Dr. Ballard.

Case XIV.—Rev. — Rowland, vicar of St. Peter's, Middlesbrough, aged 45 years; a hard-working clergyman in a very poor district. The vicarage house is situated in the midst of the poorest part of the parish, where many cases of "pneumonia" were occurring amongst the inhabitants. He had been unusually hard-worked in consequence of the epidemic and his constant attendance ministerially, often several times in a day, upon members of his flock who were ill. He used to come home daily much fatigued; he had no rest, and his general health was consequently breaking down. The following account of the illness was given me by Mr. Longbotham, his medical attendant, and by Mrs. Rowland. On Tuesday, May 1, he had not felt well and complained of fatigue and the need of rest. On the 2nd, in the afternoon, had a funeral at Ormesby, but did not get wet. On his return from the funeral he had some tea, and then went, by the request of one of his Sunday-school children, to see her father, a man named Stevens, in a distant part of Middlesbrough, and out of his own parish. This man Stevens was ill from "pneumonia." Mr. R. stayed with him about a quarter of an hour. The man was deaf, and lay in a bed, one side of which was against the wall of the room; and, as the ear nearer the wall was that which was least deaf, Mr. R. had to lean closely over the man to reach that ear, in order that what he said might be heard. After this visit Mr. R. had a service in the church, and at 9 p.m. went again to see Stevens when the same proceeding was repeated. Stevens died that same night. His medical attendant had no doubt of the nature of the illness, and the death was registered accordingly. Mr. Rowland was taken ill the next day, May 3, with rigors between 1 and 2 p.m. He went at once to bed and sent for Mr. Longbotham. He told Mr. Longbotham that "the smell of Stevens's "breath as he leaned over him seemed to knock him over." When visited first he had the usual pain in the side, and had been vomiting, but there was no diarrhœa. Subsequently he had some cough, with the ordinary pneumonic expectoration in fair quantity. Delirium commenced about the third day, not violent but "a sort of dreamy delirium," from which he could be easily roused. At the same time his strength suddenly flagged. On May 9 he vomited, throwing up black blood; this hæmatemesis occurred at intervals for two or three hours; he then turned over, vomited a large quantity of similar blood, and died almost in the act. No post-mortem examination was made. Mr. R. generally ate some rolled bacon on Sundays at breakfast but not on other days. There is no evidence of his having eaten any on the days just preceding his illness. The vicarage house is well constructed and airy, and I could discover no sanitary faults about it.

Case XV.—Sutherland, male, aged 34, residing in Southbank: being under the care of Dr. James Glen, that gentleman took me to see him on July 4. He is a stout man, was taken ill on Monday, July 2, at 4 a.m. He has now cough with rusty expectoration. There is dulness on percussion everywhere over the left back, with tubular breathing, and with friction sounds at lower part of back. On Sunday, July 1, he ate for his breakfast bacon which he had purchased at X's shop in Southbank. He had eaten no bacon on the Friday or on the Saturday. Some of the bacon used on Sunday being left, I brought it away with me and sent it to Dr. Klein. This man recovered.

Case XVI.—Sarah Barber, aged 51, residing at Southbank, lives very poorly since her husband is out of work; rarely eats anything but bread and butter; never either pork or bacon. Has not been near any cases of sickness that she is aware of. Says that for some weeks past she has had some difficulty of breathing. She is under the care of Dr. James Glen, who took me to see her on July 4. She was taken ill on Sunday, July 1, at 2 a.m., with shiverings, sweating, and pain in the side. She got up and went to the privy in the yard, where her bowels were moved and she vomited; she continued vomiting from time to time up to noon on Monday, July 2. When I saw her in the afternoon of July 4 (fourth day of illness) she was sitting up in bed, apparently finding some ease in this position. There was some cough, with rusty expectoration. Dulness on

percussion over all right back and upper part of left back. Tubular breathing in all dull parts, and loud friction sounds on both sides at base. No cardiac friction sound. I did not see her again. She ultimately died on August 2. No post-mortem examination made. In the scullery in this house, the drain from the sink stone there was found blocked up. The larder at the rear of the scullery had a ventilating opening, the ash pit and pail privy being only 6 feet distant from it.

Case XVII.—Bridget Coleman, aged 67, residing at Grange Town, was under the care of Dr. John Glen, who took me to see her on July 4. She was taken ill on Sunday, July 1, at 8 a.m. with shivering, pain in the side, and vomiting. She has now (fourth day of illness) cough, with bloody expectoration. Has had some delirium. There was dulness on percussion in both backs, with tubular breathing and friction sounds. On Friday, June 29, she had purchased 2 lbs. of bacon in Grange Town Market, and she and her sons (who have not been ill) ate of it fried at their mid-day dinner on Saturday, June 30. Some of it which was left I captured and forwarded to Dr. Klein. I did not see her again. She ultimately recovered. Lying on the bed with her grandmother was a child about 3 years old, sick and feverish, but with no physical signs of pneumonia.

Case XVIII.—Charles Green, aged 42 years, a cabman, and of very sober habits, residing at Grange Town, where he was under the care of Dr. John Glen, who took me to see him on July 4. On Monday, June 23, he drove a party in his cab to Ayton and back. He was out also at some distance from home with his cab early on the morning of Tuesday, 26th, and while away, at about 9 a.m., was taken ill: he was put into his cab and driven home. He says he did not shiver, but had a bad pain in his side. Cough came on the next day. When I saw him on July 4 (on ninth day of illness) his temperature was 99·8°, pulse 84, resps. 44. There was dulness on percussion, with tubular breathing in both backs, most marked on left side: no friction sounds observable. On the day before he was taken ill, June 25, he had had "home-cured" ham at breakfast (he says he keeps pigs and never buys bacon or ham); at dinner he had fresh meat, potatoes, and bread, and bread and milk at supper. I did not see him again. He ultimately recovered.

Case XIX.—George Fitters, aged 71 years, inmate of Middlesbro' Workhouse. Was taken ill on Sunday, July 1, and died on July 5.

Autopsy made on same day at 3.30 p.m., but hurriedly to save the post, the object being to transmit some fresh lung to Dr. Klein. The body was still warm.

Chest.—Pericardium contained a little serum. An old patch of lymph on anterior surface of heart. *Heart.*—Right auricle contained a soft red clot; pulmonary artery contained a fibrinous clot, becoming more firm and freer from red matter as it passed through the auricular and ventricular opening into the right ventricle, where it was moulded into the irregularities of the surface. Left ventricle, auricle, and aorta contained fluid blood, which ran out. *Left lung* not taken out; it was not adherent, it surface was smooth, and no induration of it to be felt anywhere. *Right lung* firm and resistant everywhere, except forepart of upper lobe, which was emphysematous. Everywhere, except in front, recent adhesions from freshly effused lymph easily broken down. Section of firm part exuded on pressure a red, slightly frothy liquid. Lower lobe friable and broke down easily under pressure. Upper lobe tougher. *Spleen* soft, but less pulpy than in some other cases examined. *Stomach.*—Small patch of ecchymosis on posterior surface near small curvature. Portion of diseased lung, wrapped in gutta-percha paper and put into stoppered bottle, forwarded to Dr. Klein on same evening.

Case XX.—Robert Dutton, aged 42 years, a stocktaker at a pipe-foundry, under the care of Dr. Ketchen, who took me to see him on July 12. Has been a teetotaller for 10 years and was not an immoderate drinker previously. He says he was as well as usual during the day of Sunday, July 8. On that day he had an egg for breakfast and mutton and sago pudding at the mid-day dinner. He had hashed mutton for

dinner on the Saturday; had eaten no bacon for a fortnight or three weeks. On the Sunday evening he went to church, feeling perfectly well, but about 6.30 p.m. had to come out on account of feeling ill, shivering, and retching. He vomited twice on Sunday night and on Monday morning, but had no diarrhœa. On the Monday evening he had pain in the left side and cough. Yesterday he had a temp. of 99 and pulse 108. To-day (fifth day of illness) temp. 102°; pulse 108; resp. 60. Has not slept. There was dulness on percussion over both backs, most at the upper parts; tubular breathing at top of left back; elsewhere harsh breath sounds. No delirium. I did not see him again. He ultimately recovered.

Case XXI.—John Wilkinson, aged 65 years, labourer, under the care of Dr. Ketchen, who took me to see him on July 12. He was taken ill on July 10 between 2 and 3 a.m. He had been at work (during change of shift) for 24 hours, namely, from 6 a.m. on Sunday, 8th, to 6 a.m. Monday, 9th, during which time he had eaten what he took with him to his work, viz., bread and butter and cold meat pie. When he came home on Monday morning he ate some ham and had a cup of tea, and then went to bed, feeling quite well. He ought to have gone to work on Monday evening, and for this purpose got up at 4 p.m. that afternoon, but he did not feel very well, and therefore did not go. Between 2 and 3 a.m. on Tuesday he had a rigor, with pain in his right side; and he vomited a little, but was not purged. I saw him on the third day of his illness. He had cough, with rusty sputa: tongue dry and slightly brown. Urine highly coloured and albuminous. Temp. 98·4°; pulse 100; resp. 36. Dulness on percussion in both backs; tubular breathing, with friction sounds over left back. Says he did not purchase the ham that he ate in Middlesbrough, but obtained it from a relative near Ripon. There is a sink in the kitchen, the pipe of which was not trapped, but ran underground to beneath the grating of the yard gully. The pantry of the house opens into this kitchen. I did not see him again. He died on July 14th. No post-mortem examination.

Case XXII.—Thomas Sanderson, aged 41 years, a grocer's assistant, under the care of Dr. Ketchen, who took me to see him on July 12. He was serving in the shop and in good health all the day of Saturday, July 7. Is living in a good, well-furnished house, and is evidently in comfortable circumstances. On Sunday, July 8, he did not go out, and about 1 p.m. ate a good dinner of lamb and potatoes. The ham he habitually eats at breakfast is of "Wright's brand," and he brings it from the shop where he serves. He had some that morning as usual, was taken ill on Sunday, July 7, at 3 p.m., but did not vomit until 6 or 7 p.m. Has had no diarrhœa. Had no pain in his side until Monday. No delirium. Looks generally brighter than other cases I have seen. Tongue white, but dryish. On July 12, when I saw him (the fifth day of illness), temp. 100·6°; pulse 104; resp. 46. He has double pneumonia; there is dulness on percussion in both backs; tubular breathing all over right back, with a great deal of friction sound at lower part; left back most dull over upper part, where there is also tubular breathing. I did not see him again. He ultimately recovered.

Case XXIII.—John Clark, aged 30 years, under the care of Dr. Hedley, who took me to see him on July 12. He works at the North-Eastern Steel Works. He was not at work on Thursday and Friday, July 5 and 6, and on Saturday, July 7, was at home all day, except that he went out for a walk. On that day he had a chop for his dinner. On the 5th, 6th, and 7th he had at breakfast bacon which he purchased at X's shop in Middlesbrough; says he always buys it there. He was taken ill on the Saturday night, July 7, about midnight. When I saw him on fifth day of illness there was a little herpes on his lower lip (the first and only occasion on which I had noticed this symptom). Tongue moist, but white down the centre. Complained of a little pain under left axilla when he coughed. Temp. 99°; pulse 60; resp. 20. There was slight dulness on percussion in both backs, with a little friction sound, but no

tubular breathing. The pulse was 104 on the 9th. I did not see him again. He ultimately recovered. It was a slight attack. There were many similar slight illnesses as the epidemic subsided.

Case XXIV.—John Kay, aged 50 years, an Irish labourer, living miserably in a dirty house; was under the care of Dr. Hedley. Went to work at the North-Eastern Steel Works on Saturday, July 7, at 6 a.m., but at 7 a.m. had an attack of shivering with headache and pain in his left side. Cough commenced after the pain. Has had no expectoration. When I saw him on the sixth day of his illness there was a white fur on tongue. Temp. 100·6° (it had been as high as 103·5°); pulse 104; resp. 30. There was dulness on percussion all over left back, with tubular breathing. Right back generally not dull, but with exaggerated breath sounds. Has eaten no bacon since he had his tea on Thursday evening, about 40 hours before he was taken ill. It was purchased at "German Harry's" shop, in his neighbourhood. I did not see him again. He ultimately recovered.

Case XXV.—Thomas Walter, aged 38 years, a furnace-man at North-Eastern Steel Works, under the care of Dr. Hedley, who took me to see him on July 12 (Thursday). For some years he has been subject to cough. It appears that all the week previously he had been on the night shift, and he came off work on Saturday morning. On the Saturday afternoon he went on a railway excursion to Hartlepool, and felt very cold when returning in the evening. He says he was well, however, all day on Sunday, and was walking about in the town. Was taken ill on Monday, July 9, at 3 a.m., with rigors and pain in his right side. He took an emetic of mustard and milk, a favourite remedy among these labouring people "to get rid of the slag dust," which they regard as the cause of the disease. There is now (fourth day of illness) cough with a considerable amount of expectoration, which is rusty, with a little frothiness. Tongue is white, and a little dry. Temp. 101°; pulse 100; resp. 25 (on Monday the temp was 103°). Had some delirium yesterday. There was dulness on percussion in both backs, with sonorous rhonchi most on right side. I did not see him again. He ultimately recovered. This was apparently a slight attack in an habitually bronchitic man. As regards his food, he said that on the Saturday he had an egg for his breakfast, a chop for his dinner, and some bread and cheese in Hartlepool. On Sunday he had some bacon slightly cooked in a Dutch oven for breakfast, and beef for dinner. The bacon, he said, was from Roberts, a farm labourer at Ayresome Lane, near the workhouse.

Case XXVI. (Cottage Hospital, North Ormesby. History of case by Dr. Knott. Autopsy by Dr. Malcomson.)—Dennis Murphy, aged 40 years, an ironworker, was at his work on Monday, June 18th, and went to bed after a good supper at 10 p.m. At 1 a.m. on 19th awoke feeling ill, with pain in right side, and later on had pain at upper part of left side of chest anteriorly. At 8.30 a.m. he began to vomit; the vomited matter contained no blood, and consisted mainly of tea and water that he had drunk. Was admitted into hospital at 7 p.m., June 21; he had then no vomiting and no diarrhœa. He had cough, with scanty expectoration free from bloody tinge, yellowish-white and thick. Temp. 104·4°. He complained of pain in the right side and also of pain in the left leg, reaching up to the knee, and he could only move it with pain and difficulty; the toes were red and rather swollen. The right leg was normal. He was much exhausted, but there was no delirium. There were physical signs of double pneumonia and of pleurisy anteriorly at base on right side. On 22nd in morning his temperatnre was 102° and the same in the evening. At about 4 p.m. delirium set in, and continued increasing until he died at 12.40 (midnight), after four days illness.

Autopsy.—34 hours after death. Rigor mortis well marked, and decomposition commenced.

Chest.—Pericardium contains ½ oz. of fluid. No evidence of pericarditis. *Heart.*—Right auricle and ventricle filled completely with a tough, white, ante-mortem clot, which extended into the large vessels.

App. A. No. 18.

On Pleuro-pneumonic Fever in Middlesbrough and neighbourhood; by Dr. Ballard.

Left auricle and ventricle firmly contracted, and containing a small white clot. Heart of normal size and valves healthy. *Right pleura.*—Thick coating of recent yellow lymph almost everywhere, a few old adhesions at anterior portion of base of lung. Pleura contained about 10 ozs. of dirty-looking drab-coloured serum. *Left pleura.*—Some recent lymph about apex of lung over a space of about 2 inches square. Lower lobe of lung covered with a thin layer of recent lymph. Pleural cavity contained about 4 ozs. of serum, clearer than on right side. *Right lung* consolidated at base and all along posterior portion. Apex and front edge crepitant; lower lobe friable. On section chocolate-coloured fluid ran out in abundance. *Left lung.*—Upper lobe at apex and base solid, middle part crepitant. Lower lobe solid, except fringe of lower border. Section of upper lobe mottled, with dark and slate-coloured patches; dirty, chocolate-coloured fluid ran out in abundance. Lower lobe more solid, but chocolate-coloured fluid ran out freely.

Abdomen.—Liver.—Smooth on surface enlarged and dry, with nutmeg appearance on section; weight 5 lbs.

Spleen.—Substance very friable, and on pressure seemed to melt into a creamy, chocolate-coloured fluid; weight 4½ ozs. *Stomach*, distended with gas, contained a small quantity of milk food. Cardiac end congested, with small spots of ecchymosis. Between cardiac and pyloric ends and running completely round stomach, but most marked in large curvature, about 6 square inches of mucous membrane pale green, with congested vessels underneath; over about 3 inches square of the congested area dark arborescent vessels as if injected with ink (post-mortem changes?). *Left kidney.*—Surface smooth and even; capsule strips off easily. Section dry, rather pale; weight 7 ozs. *Right kidney.*—On surface showed mottled, bluish-coloured patches, and a few slight, smooth depressions. Section dry and pale; weight 6 ozs.

Case XXVII.—(Clinical history by Dr. Hedley. Autopsy by Dr. Malcomson.)

R. Simpson, aged 47 years, residing at North Ormesby, a labourer at chemical works, was working on the night-shift, when he was taken ill, in the early morning hours of June 28, with a shivering fit. He developed pneumonia of the whole of the right lung, with prune juice sputa, very rapid breathing, and profuse sweats. About the 9th or 10th day he was better, and by the 13th day of his illness, *i.e.*, July 10, his temperature was about normal, and for some days subsequently he appeared, although weak, to be recovering satisfactorily, but slowly. On Tuesday, July 17, however, a relapse took place, with high temperature, rapid pulse, and evidence of double pneumonia. He died on July 24.

Autopsy.—24 hours after death. *Chest.—Pericardium* contained about one ounce of blood-stained serum; otherwise healthy. *Heart* enlarged, flabby, pale on section, and fatty looking. Right ventricle filled with tough, white clot which extended into auricle and into pulmonary artery. Left ventricle dilated. It contained a small pale clot, which reached into the aorta. All three aortic valves diseased, the right posterior valve had attached to it a large fungus-like growth or vegetation projecting into the ventricle, of the size of a small hazel nut, soft, semi-gelatinous, and had in its centre a large perforation capable of admitting an ordinary pencil. The left posterior valve thick and rough, had a torn edge, the torn part projecting like a soft wart. In the sinus behind this valve was a circular ulcer, ¼ inch diam. exposing the muscular tissue. Anterior valve thick and roughened. *Right pleura* contained about 3 ozs. of bloody serum; old adhesions firm and broken down with difficulty at base and posterior and lateral part of lung. *Left pleura* also contained about 3 ozs. of bloody serum, and presented similar adhesions, but also some slight adhesions at apex. *Right lung* solid throughout, save the anterior fringe. On section, at apex an abundant discharge of chocolate-coloured, frothy serum; cut surface claret-coloured, mottled with very dark points; pieces from this part float in water. At base cut surface darker; pieces did not float in water. *Left lung.*—Anterior margin of upper lobe crepitant; base solid: otherwise same as upper lobe of right lung; lower lobe solid throughout.

Abundant flow of chocolate-coloured fluid on section; portions from all parts floated in water.

Abdomen.—Liver greatly enlarged; section mottled, with nutmeg appearance. Gall bladder nearly empty. *Spleen* enlarged; length about 7 inches. Section chocolate coloured, soft, and pulpy. *Stomach* contained 6 ozs. of a very dark-coloured fluid, like partly digested blood mixed with bile; along the small curvature a patch of mucous membrane, size of the hand, intensely injected, with punctiform ecchymoses arranged in clusters, most marked near the pyloric and cardiac orifices. Vessels of remainder of stomach engorged and arborescent, but membrane free from hæmorrhagic spots. *Intestines* healthy and Peyer's patches normal. *Right kidney* normal size; capsule adherent; one pale cyst, size of hazel nut, in substance of kidney; it contained a pale fluid; pyramids small and dark coloured; inter-pyramidal cortical part enlarged, pale; peripheral cortex thin and pale. *Left kidney* normal size; two small depressions on the surface; pyramids small, almost squeezed out of existence by enlarged and thickened inter-pyramidal substance.

Case XXVIII. (North Riding Infirmary, Middlesbrough. By Dr. Hinshelwood, resident surgeon.)—Charles Duncan, residing at South Bank, aged 45 years. Admitted June 5, on the fourth day of his illness. There was neither vomiting nor diarrhœa while he was in hospital, nor any delirium. The left base of lung was involved. On June 8th, the seventh day of illness, the temp. fell from 102·4° to normal. He recovered rapidly and uninterruptedly, and was discharged on June 20. Temp. chart No. 1.

Case XXIX.—Robert Wright, aged 24 years, a fitter, under the care of Dr. Walker, who took me to see him on July 4. He said he was taken ill on Thursday, June 28th, at 2 p.m., while out walking. He had not been at work for the previous three weeks, because he did not feel strong, and had pain across his back. He said his illness commenced with pain in his right side. He went into a public-house and there had a shivering fit, and, at the recommendation of the publican, drank two glasses of raw brandy. On his way home he called on Dr. Walker. He has had vomiting, but none since July 1. When I saw him on July 4 (seventh day of illness) he had temp. 99·4°; pulse 84; resp. 40. There was dulness on percussion over right back, especially over upper half, with tubular breathing everywhere, and abundant friction sounds over lower half. Left back also rather dull, with harsh breath sounds. He was admitted into North Riding Infirmary on the same day. Dr. Hinshelwood's notes of the case thereafter are as follows:—During the first two days after admission, viz., on July 4th and 5th, he had delirium of low muttering type, and was constantly trying to get out of bed. On July 6th his temperature fell from 100·6° to 99°, and the delirium ceased. His bowels were first moved on that evening. From this time he steadily improved and was discharged on July 23rd. Temp. chart No. 2.

Case XXX. (North Riding Infirmary, Middlesbrough. By Dr. Hinshelwood.)—John Phipps, aged 21 years, employed at the North-Eastern Steel Works. Was at work on the night-shift on Thursday, Oct. 11. Went to bed on his return from work on Friday morning. After getting into bed felt cold, had rigors, and vomited two or three times. Ultimately he fell asleep. Towards evening on Oct. 12 felt pain in side and could not rest. Admitted into hospital in the afternoon of Oct. 13, on second day of illness. Pulse 116; resp. 60; temp. 102·4°. Dulness at right base in front and behind. At upper part of dulness coarse friction sound. Increase of vocal fremitus, but absence of vocal resonance except over several isolated areas where it is increased. Oct. 14.—Skin and conjunctivæ yellow. Pulse dicrotic. Dulness the same. Coarse friction sounds and tubular breathing marked on certain areas; towards lower and posterior part of lung physical signs point to fluid in pleural cavity. Oct. 15.—Urine albuminous. Upper lobe of right lung now involved. Oct. 16.—Whole right lung solid; tubular breathing and coarse crepitation (? friction sounds) everywhere. Oct. 17.—Restless night and slight delirium. Apex of heart displaced downwards and to left as if fluid were accumulating in right pleura. Oct. 18.—Low muttering delirium, but not

violent. Apex of heart displaced more, almost to line of nipple. Oct. 19.—Face dusky and livid; restless and delirious during night. No change in physical signs. Oct. 20.—Had a good night and slept very well; slightly delirious. Sweated freely during night, bed quite wet with it. Temp. below normal. Throughout all this period of illness never had much cough and very little expectoration which was tough and viscid, and not rusty. Skin is now clear, duskiness and lividity having disappeared. From this time he steadily improved. The physical signs indicated gradual absorption of the pleural effusion and clearing up of the pneumonia, and by Oct. 28 he was nearly well enough to be discharged. Temp. chart No. 3.

Case XXXI. (North Riding Infirmary, Middlesbrough. By Dr. Hinshelwood.)—Arthur Trainer, aged 25 years, labourer at the North-Eastern Steel Works. Has always been strong and healthy until present illness. On Friday, June 22, went to work as usual, but after working about two hours began to shiver, and felt so ill that he had to go home. Went to bed and vomited several times. On Saturday he continued vomiting and was "loose in his bowels." On the Sunday he again vomited several times, but had no diarrhœa. Then pain commenced in his left side, with cough; the coughing increased the pain. Admitted Monday, June 25. He had then considerable pain in left side. Physical signs showed that base of left lung was solidified but right lung was unaffected. June 26.—Only slight pain. Urine, 30 ozs., *specif. gravity* 1,020, slightly albuminous. Base of right lung now involved. June 27.—Slightly delirious during night. Urine still albuminous. June 28.—Vomited several times during night and this morning; delirious, but not violently, all night. Urine free from albumen. June 29.—Delirious and violent all night. Urine not albuminous. June 30.—Delirious all night, but not violent. Passing motions and urine into bed. July 1.—Again delirious all night, but not violent. Slept a little, and is sleeping quietly this morning. Has taken nourishment freely. Has still been passing motions and urine into bed. July 2.—Has not passed motions and urine into bed; slept a little, and only slightly delirious. July 3.—Slept during night; no delirium. July 4.—Similar report. Temp. normal. From this time he got gradually better, and on July 15 was sufficiently recovered to be discharged. Temp. chart. No. 4.

Case XXXII.—William Clare, aged 30 years, labourer at ironworks; under the care of Dr. Veitch, who has been good enough to give me the following notes of the case:—Had been feeling "out of sorts" for a week or two. On the night of Thursday, December 6, had a shivering fit, which was followed by diarrhœa; had vomiting on the Friday. When Dr. Veitch saw him first on Saturday, December 8, he had a slight cough, and complained of sleepless nights, but the vomiting and diarrhœa constituted the prominent ailment. Temp. was 99·4°; pulse, 100; tongue dry and furred; thirst, but no headache. December 9.—Vomiting and diarrhœa better, but coughs more, and has pain in left side; expectoration slightly rusty. Temp. 101°; pulse 100. Sleepless, but takes nourishment well. Dulness on percussion over left base of left lung. December 10.—Skin dry from the first; delirious at night; copious expectoration of olive green and rusty, viscid mucus. Temperature, 102·5°; pulse 110. Dulness extends to nipple. Continued much the same until December 13, when temp. was 102° and pulse 120°. December 14.—No delirium last night. Sputa copious and brighter red in colour. Skin moist. Temp. 102°; pulse 108°. December 15.—Had no delirium; perspiring freely. Sputa less in quantity and more frothy, tinged only with red. Temp. 99°; pulse 90. December 16.—Left wrist stiff and painful. Temp. 99°; pulse 80°. In a few days the affection of the wrist passed off; he gradually improved and was convalescent on December 26. Sputa sent to Dr. Klein: found to contain his *bacillus pneumoniæ*.

Case XXXIII.—Owen Early, aged 63 years, a bricklayer's labourer and an inmate of Middlesbrough Workhouse. He was admitted as an inmate on November 13. Almost immediately after admission to the workhouse he was made wardsman of the "pneumonia ward" (a ward which had for some months been set apart for the reception and isolation

of cases of pneumonia admitted into the workhouse or arising therein). There were during the time he was wardsman several cases in the ward, some of which died and some of which recovered. All these cases had been brought in sick from the town. *For a considerable time there had been no case of pneumonia among the inmates.* Early's duty as wardsman was to assist the female nurse and to obey her directions, removing discharges, and assisting generally: he was thus brought into close and constant association with cases of "pneumonia" for about a month before he was taken ill. I may say that the female nurse remained unaffected. Mr. Longbotham says that Early had a slight rigor on December 10, followed by severe bilious vomiting, which continued on 11th, when he complained to the doctor. On December 13 Mr. Longbotham says that there was distinctive pneumonic expectoration and the skin was dusky. There was dulness on both sides of chest. He had no pain at any time. He died on December 15. Sputum was sent to Dr. Klein for examination: found to contain his *bacillus pneumoniæ*.

Autopsy, December 16.—(By Dr. Malcomson and Dr. Hinshelwood.) *Pleura.*—Left lung had old adhesions throughout. Right lung, old adhesions on anterior surface and recent adhesions on posterior surface. *Right lung.*—Grey hepatisation of lower lobe; very little fluid exudes on section, and pieces of the lobe sink in water. Upper lobe engorged but crepitant, and pieces float in water. *Left lung* atrophied apparently from an old pleurisy, but it is spongy, crepitant, and floats in water. *Heart* enlarged and fatty. White tough ante-mortem clot adherent to the valves of the right ventricle; in right auricle a similar clot fills the cavity completely, and is moulded into it exactly. Left auricle and ventricle empty. Some hardening of mitral valves, but otherwise valves normal. *Pericardium* normal and free from effusion.

Abdomen.—Stomach greatly distended with gas and fluid. Over both anterior and posterior mucous surface dark arborescent vessels observable, but only towards the pylorus were there distinct red and arborescent hœmorrhages. Similar hæmorrhages observable in duodenum. *Spleen* rather small, but firm in consistence and healthy in appearance. *Liver* normal.—*Kidneys* apparently normal.

Brain.—Normal.

There was a pickled pork (home cured) ration served out on December 7 and December 10, to which, as wardsman, he was entitled, and it is presumable that he had it. When he was taken ill on December 10 the nurse says he vomited his dinner.

Case XXXIV. (North Riding Infirmary, Middlesbrough.) Clinical record by Dr. Hinshelwood.—Robert Watson, aged 25 years, employed as a labourer at North-Eastern Steel Works. Was quite well and at work on Monday, November 19, and also when he went to bed that night. About an hour after he had gone to bed he was awoke by acute pain in the right side. He was shivering and perspiring all night, and had no sleep. On 20th he began to cough, and sent for a medical man. That night he took a dose of castor oil, which purged him. Admitted to hospital on evening of November 21, but was not carefully examined until next morning. November 22.—Slept fairly during night; pain in side less acute; cough, but very scanty sputa; urine albuminous. Whole of right side dull with tubular breathing and increase of vocal resonance. At the base, however, the physical signs point to effusion. November 23.—Restless at night, but no delirium; cough distressing, but very scanty sputa. November 24.—Report similar to yesterday, but to-day complains, in addition, of pain in left side; dulness there on percussion and tubular breathing, with crepitus (? friction). Great dyspnœa; face dusky, livid, and superficial veins congested. Apex of heart somewhat displaced towards left; impulse diffused and irregular; cardiac thrill. Very restless, but no delirium now or at any time since admission. Died at 8 p.m. Temperature chart No. 5.

Autopsy 49 hours after death.—A powerfully-built man, in fine condition of nutrition; extensive post-mortem lividity at sides as well as back of trunk, neck, and limbs; scrotum almost black. *Head.*—Sinusses of dura mater full of soft coagula; no separation of fibrine; vessels of meninges full; basilar artery contained a coagulum, part of which was a

thread of separated fibrine. *Brain.*—Grey matter dark coloured, substance of brain firm; little liquid in lateral ventricles. *Chest.*—*Left lung* moderately congested; non-adherent; all parts floated in water. *Right lung* strong, old adhesions to diaphragm; pleura contained somewhat more than half a pint of turbid serum. Recent lymph on pleural surfaces and between lobes. Middle and lower lobes advanced to stage of grey hepatisation; upper lobe much congested, but little frothy fluid exuded from cut surface on pressure; all parts sink in water. *Heart* largish; abundant coagula in all the cavities; slightly fibrinous in the right cavities, but in the left auricle and ventricle very largely composed of separated fibrine firmly adherent to the walls and entangled among the fleshy columns and muscular irregularities; it extended also into the aorta.

Abdomen.—*Liver* large, adhering firmly to diaphragm; on section pale and coarse looking. *Spleen* normal size, chocolate colour on section; soft, and broke down under moderate pressure, but not so pulpy as in some other cases. *Stomach* empty; presented nearly everywhere in mucous membrane large ecchymosed patches; the part most free from them was the large curvature, but here the mucous membrane was much softened; the largest and most pronounced patches were about the small curvature, especially towards the pyloric end. *Kidneys* largish; capsules stripped off readily without bringing tissue with them; section pale; cortical substance coarse looking and disproportionately large in amount; pyramidal portion shrunk, as if encroached upon.

Case XXXV. (Notes by Dr. Bateman.) Mr. W. White, aged 45, contractor at iron works, was attacked with lobar pneumonia on July 3. He was recovering, and on the ninth day of illness the lung was found to be clearing up, and the dullness to have lessened considerably. On the eleventh day (July 13), he was able to get up and dress himself. On the thirteenth day, however, when apparently making a good recovery, he suddenly lost the sight of his right eye. On the following day the eye looked very dull and hazy, his temperature had risen, and he had headache and delirium. The eye became completely disorganised and meningitis was fully developed. He died on July 17. No post-mortem examination.

ADDENDUM B.

Dr. Klein's Report.

Dr. Klein's Report on certain Pathological and other Material forwarded to him by Dr. Ballard from Middlesbrough.

The investigations upon which I now report have been directed to determination of the following points:—

I. The microscopical anatomy of the diseased lung and other organs or tissues of the bodies of Middlesbrough persons dead of pneumonia. Also what micro-organisms, if any, were to be found in such diseased lung, organs, or tissues; and what are the characters of such micro-organisms?

II. Whether the juice of diseased portions of lung from Middlesbrough pneumonia cases had the power of inducing similar pneumonia in lower animals, and, if so, whether any single species of micro-organism present in the diseased human lung had by itself the same power of inducing pneumonia? Further, whether—in the event of pneumonia being experimentally induced in either or both of the above ways in lower animals—any (and, if so, what) micro-organisms were to be obtained from the tissues of the animals in which the pneumonia had been thus artificially induced?

III. In addition, inquiry was extended to another point, namely, the pathogenic qualities of certain samples of bacon which had come under suspicion as having had to do with attack by pneumonia of Middlesbrough people.

I.—Microscopic Anatomy of diseased Lung and other Tissues of Persons dead of Middlesbrough Pneumonia.

On Pleuro-pneumonic Fever in Middlesbrough and neighbourhood; by Dr. Ballard.

Microscopic examination of the diseased tissues of human subjects, with especial search for micro-organisms in the lung and in fresh heart's-blood, and examination also of the hardened tissues of the liver, kidney, lymphatic glands, and spleen (specimens having been prepared after customary methods and stained with various anilin dyes, as, for instance, Löffler's methylin blue, and also after Gram's method), failed at first in the discovery of any micro-organisms. A like negative result as regards detection of micro-organisms followed inoculation with heart's-blood of nutritive gelatine in tubes and on plates, with incubation of these at 20° C. So, too, with similar inoculation of broth, of Agar mixture with broth peptone, and of Agar mixture with beef infusion peptone and glycerine,—incubated all of them at 35—38° C., no growth of any kind occurred in these media.

Micro-organisms not readily detected in diseased tissues,

But an altogether different result was obtained when the *juice* of the inflamed lung of pneumonia cases came to be experimented with. This lung-juice was obtained thus:—Portions of diseased lung (obtained in several instances within 20 hours of the death of the patient) were placed in strong solution of perchloride of mercury, and well washed therein for five to ten minutes until the superficial parts of the lung-tissue were quite coagulated and opaque. Then, with a sterile scalpel, an incision was made into the specimen, and the sanguineous fluid exuding from the cut surface was used for making cover-glass specimens and for the inoculation of various culture media.

but in lung-juice abundance of bacilli.

Microscopic examination of this lung-juice in a fresh state revealed the presence in it of short bacilli, singly and in dumb-bells (Fig. 1, p. 329), with here and there a bacillus (single or dumb-bell) possessed of active movement, spinning round and round with great velocity, or darting backwards and forwards across the field of the microscope in various directions. The number of such motile bacilli was very small, but in size and aspect they did not appear to differ from the others.

Their morphological characters.

Cover-glass specimens prepared after the Weigert-Koch method from the same lung-juice showed, after staining with gentian violet, bacilli also, but in varying numbers. In some samples their number was not great, though several were under view in each field of the microscope; in other samples the organisms were extremely abundant. They were apparently of one kind; oval rods rounded at the ends, and arranged generally as dumb-bells, though in some cases a chain of three or four shot rods could be detected. Each rod of the dumb-bell was now and again constricted in the middle. When a cover-glass preparation is well washed the rods show at each end a deeply stained part, the middle portion remaining of a faint colour, after a fashion which in former years was considered characteristic of bacterium termo. As regards length and thickness the majority of these microbes are also comparable to bacterium termo, being only twice as long as thick; but there is no difficulty in finding, amongst the several single and dumb-bells forms, rods of such length as indicates that they are bacilli. And examination of cultivations of the organism further proves this.

They differ from Friedländer's bacillus;

Amongst the single rods many are more or less constricted in the middle, and thus resemble a diplococcus, but forms intermediate between such diplococci and distinct bacilli show their real character. So far as the cover-glass specimens were concerned, no definite conclusion could be arrived at as regarded the unity of the organisms present; but this much could be definitely said, namely, that none of the bacilli of Friedländer could be found in any of the specimens from the various bodies examined. There were present no bacilli with a capsule, although in preparations in which the ground was not sufficiently washed there did appear around the bacilli a narrow clear halo, but of the well-known capsule surrounding the bacillus of Friedländer nothing could be seen, and, as cultivations subsequently proved, there were no bacilli of Friedländer in these lungs.

and from Fränkel's micro-organism.

The above-mentioned short rods with constricted centre, and the dumb-bell rods each of them with a constricted centre, could of course easily be taken for the diplococcus pneumoniæ of Fränkel and Weichselbaum. As regards their size this was quite possible, though not probable, on account of the presence of numerous intermediate forms between single bacilli and dumb-bell bacilli. Cultivations, however, proved my surmise as to the absence of the above diplococcus correct. From four typical pneumonia cases numerous cultivations were made of the lung-juice, and in none of these was the resulting growth that of the diplococcus of Fränkel and Weichselbaum. As will be presently mentioned, the predominating growth, and one obtained indifferently from all the pneumonia cases, was an organism which is identical in morphological characters with that found in the cover-glass specimens of the fresh lung-juice, and this organism in cultivation proved different not only from the Fränkel and Wiechselbaum diplococcus pneumoniæ, but also from Friedländer's bacillus.

Further search within diseased tissues for this bacillus; by microscope;

Further microscopic examination of fine sections of hardened and inflamed pieces of the lung showed that the alveoli were filled by exudation. This consisted of a fibrinous or amorphous granular substance, and in it were numerous leucocytes, along with epithelial cells swollen and detached. Different alveoli in the same and adjoining lobules differed from one another in the number of leucocytes enclosed within the fibrinous and amorphous exudation; but I have not been able to find red blood corpuscles in any appreciable number in the exudation, such as are constantly present in red hepatisation. Although the pieces of lung under consideration had the general characters of a croupous lung in the stage of red hepatisation, I can find leucocytes and but occasional red corpuscles in some few alveoli. The capillaries in the alveolar walls were much engorged, so were also the large vessels leading into or from them; in the interalveolar tissue there were numerous leucocytes, but they were not uniformly distributed, since they were absent from one part of a lobule while numerously present in another part.

As to other viscera examined:—In sections through the *liver* all the liver cells were found in a state of pronounced opaque granular swelling; in some places these cells showed granular disintegration, in others they were filled with fat droplets. In the *kidney* there was slight glomerulo-nephritis; many of the convoluted tubes showed cloudy swellings and in a few straight tubes of the medulla hyaline casts were seen.

To facilitate detection of micro-organisms within the diseased tissues, sections of the lung hardened in alcohol or in Finkler's fluid had been stained in Weigert's gentian violet, with and without Gram's method, and in Löffler's methylin blue. On further examination of these specimens after staining, the bacilli so numerously present in cover-glass specimens of the fresh lung-juice were very difficult of detection. The reason is this: that these bacilli cannot withstand washing in alcohol; it rapidly extracts from them their colouring. Here and there in these sections a few of the bacilli could be detected in the interalveolar tissue as well as in the contents of the alveoli themselves, but there was no comparison in this respect between the two sets of preparations. And on account of the easy decolourisation of the bacilli after staining, by washing the sections in alcohol (for purposes of dehydration), I should not like to be sure of the absence of the bacilli from the other organs mentioned above, though it has to be remembered that the negative result of the cultivations made from the heart's blood go far to prove the blood of the general circulation free from these bacilli.

and by culture.

From the lungs of several of the pneumonia cases cultivations were made as described above. The cultivations were in gelatine, in tubes and in plates at 20° C., and in Agar mixture, in tubes and in plates at 36° C. (96·8 Fahr.). The organisms isolated were the following:—

In a single case, a staphylococcus very slowly liquefying the gelatine; it takes several weeks to produce slight liquefaction. It forms on the surface of the solid gelatine in streak cultivations a film of a whitish colour with a tinge of yellow; the film increases in thickness during the

first few weeks, and only after two weeks or more is there any trace of liquefaction.

In another of the cases there was present a short bacillus which does not liquefy the gelatine and which forms round flat colonies of a whitish colour with a fringe of pink. In stab cultures of this bacillus the track of the needle is marked after several days incubation by a whitish line, and on the surface is a prominent convex knob, thus resembling Friedländer's bacillus pneumoniæ; but it is distinctly different from it in colour, and also under the microscope the cultures differ in size and arrangement of the bacilli.

In a third pneumonia case I found a micrococcus (staphylococcus) forming minute, grey, round colonies, not larger, after one or two weeks growth, than the head of a small pin. This micrococcus does not liquefy the gelatine. It grows in the same way on Agar mixture, viz., forming small, circular, grey colonies. In streak cultivation on gelatine or Agar mixture this organism forms along the track of the needle a whitish-grey line.

Bacillus in every case present in the lung-juice.

But in all the pneumonia cases examined there was isolated by cultivation from the lung-juice an organism which, judging from the number of colonies that appeared in the plate cultivations, must have been present in the lung-juice in tolerably large numbers. This organism on further subculture (Figs. 3 and 4, p. 330) was found to correspond in morphological respects with the minute bacilli described as present in cover-glass specimens of the fresh lung-juice.

Its cultural characters.

In gelatine plate cultivations and on the surface of gelatine over which a droplet of lung-juice had been spread with the platinum wire, there appeared after two or three days whitish-grey spots, just perceptible to to the eye, which enlarged in the next day or two into flat, translucent, greyish-white plaques, with irregular serrated outline (Fig. 6-1). During further enlargement on subsequent days the plaques became very thinned out in the marginal parts and at the same time very fringed and serrated. The colonies at their maximum development, which is attained after about two weeks, are flat, thinner at margin, thicker in centre, of a translucent appearance, and of a whitish-grey colour. There is a remarkable difference in size between colonies growing on the surface of the gelatine plates and those appearing on the surface of gelatine in tubes. In the latter the colonies, if well isolated, grow to considerable breadth, up to $\frac{1}{4}$–$\frac{1}{2}$ inch in diameter, becoming at the same time very irregular in general shape (Fig. 7, A); whereas on the surface of gelatine plate the colonies retain a more regular general outline and never reach such a size as in the gelatine tubes; not more than $\frac{1}{8}$–$\frac{1}{4}$ inch is the diameter of the largest of these plate colonies. The colonies in the depth of the gelatine are small and spherical, their diameter not more than that of the head of a small pin. Under a glass their colour is faintly brownish-yellow (Fig. 6–2). In a *stab culture* the track of the needle becomes, on incubation, marked as a whitish-brown line, composed of minute spherical colonies closely aggregated. When the growth reaches the surface it spreads out into a greyish-white thin film, with serrated margin. On the surface of gelatine *in streak cultivation* the growth forms a whitish, thin film, which gradually enlarges in breadth, and as it does so assumes a very irregular and serrated outline; in the middle, *i.e.*, in the track of the needle, the growth is thickest. After about a fortnight the growth has reached its height. The character of the growth is the same in Agar mixture, except that it takes place much more rapidly, being incubated at 36° C. The serrated outlines of the colonies of a streak culture on the surface do not appear till the growth has somewhat progressed in extent. All these facts prove that this bacillus grows very much more copiously and more rapidly when in contact with air. It belongs, therefore, to the class which is called aerobic. Alkaline broth inoculated from the growth and incubated at 36° C. (96·8 Faht.) becomes uniformly turbid already after 24 hours, and the turbidity increases during the next day. A whitish, loose, powdery or floccular precipitate makes its appearance, and this by the end of the week is considerable in amount. By this time there are

present on the surface, occasionally, a few small scales and particles loosely aggregated as if attempting to form a pellicle, but there is no distinct pellicle formed. The culture does not, even after many weeks, lose its turbidity. On potato (steamed for 40 minutes), the growth at 36° C. forms after 24–48 hours a thin moist film, irregularly outlined, and of a faint yellowish-brown tint. The film increases in breadth and slightly in thickness during the next few days, and its tint becomes more pronounced. At the end of a week or ten days the growth has reached its maximum, and looks now like a moist brownish-yellow film, corrugated, and irregularly outlined.

Examining the bacilli of these various cultivations in the fresh state, as well as after drying and staining in the same way as those obtained from the fresh lung-juice, their identity with the latter cannot be doubted. Samples taken from the cultivations on gelatine or Agar mixture, and examined in the fresh state in a drop of sterile salt solution, show that the great majority of bacilli (single or dumb-bells) are resting, or exhibit only the ordinary Brownian molecular oscillation; while a minority of them is actively motile, darting to and fro, or spinning round and round. The number of these motile bacilli is greater when the sample is taken from the superficial layer than when it is derived from the depth, *e.g.*, from the depth of the thicker part of a culture several weeks old; hence a sample from a recent culture, where the film is everywhere thin, shows more motile forms then if derived from an old culture, *e.g.*, after several weeks. [It must be clearly understood that there is no question here of accidental contamination of my cultures. I have devoted to this point special attention, and I have examined specimens made of large numbers of colonies from excellent plate cultivations, from which at the same time further plate cultivations were made, the progress of which proved the purity of the colonies furnishing in the first instance samples for microscopic examination.] It is extremely curious that I have not met with any of these motile bacilli in cultures made in alkaline broth peptone, after three or more days growth. After 24 hours and during the second day one meets with some that are motile, but later on these forms are absent. This is, I presumed, connected with want of oxygen supply, since such a culture in fluid broth would in this respect be incomparably worse off than a growth of the bacillus on the surface of gelatine or of Agar-Agar. For testing the question I started from a given colony in a gelatine plate cultivation two series of subcultures: (1) in alkaline broth, and (2) in gelatine plates or in a gelatine by streak culture. After a few days growth, on examining the specimens, I found that the motile forms were not present in series (1), but were present in series (2). I then made from the broth cultures destitute of motile bacilli, further gelatine plate cultivations and gelatine tube cultivations. On samples being examined in the fresh state after a few days growth, I found that the motile forms were present in them.

And morphology under further subculture.

In all cultivations there are present amongst a majority of short dumb-bell bacilli, some single bacilli that are conspicuously longer than the rest, and about whose bacillary nature therefore there can be no doubt. In this connexion, I refer the reader to the photograms accompanying this report. At first sight one would, I admit, be inclined to regard these longer bacilli as accidental contaminations, and not as of the same sort with the rest; and this view I myself took when first meeting with them in cover-glass specimens made from tube cultivations. But I have now thoroughly convinced myself that these longer bacilli are really of the same species as the short ones, since in cover-glass specimens from well-isolated colonies growing in very carefully prepared plate cultivations, a few of these longer forms are always to be met with amongst a multitude of short oval bacilli and dumb-bells.

In specimens taken from cultures several weeks old there are numerous forms present which indicate an involution and degeneration of the bacilli; the bacilli become very much thicker, almost spherical or slightly oval, and ultimately the protoplasma disappears leaving behind an empty sheath. The same involution process occurs in the long forms, which

become very much thicker, irregular in outline, and ultimately their protoplasma becomes granular and disappears (Fig. 5, p. 331).

I have paid special attention to spore-formation in these pneumonia bacilli, but have failed to see anything that would indicate it. Neither on gelatine, nor on Agar mixture, nor in broth, nor on potato, have I seen in the bacilli that appearance of bright corpuscles which in other bacilli is known to be connected with and to lead up to the formation of spores. I have seen in some of the longer bacilli appearance of irregular granules,* but these could not be identified with spores, being evidently connected with granular degeneration. The aggregation at the ends of the short forms of protoplasm staining readily with dyes has already been mentioned; it is a character common in many species, particularly in those formerly considered as belonging to bacterium.

It does not form spores.

In addition I have made a series of experiments which seems to me to confirm my other observations as to the absence of spores in these bacilli. Drying thoroughly samples of thin film from cultures several days to several weeks old, on sterile cover glasses, and introducing the latter into test tubes containing sterile broth which are then incubated at 37° C., it will be found that the test tubes remain free from growth. It is necessary, however, for success of this experiment, that the film in question be very thin and the drying complete; if the film be not thin, the drying will need to be very prolonged to ensure killing all the bacilli that are present.

Also, I have, after inoculation of broth tubes with matter of active cultures (gelatine and Agar Agar) several weeks old, exposed such tubes for five minutes to a temperature of 75° C. Upon subsequent incubation at 37° C. these broth tubes remained altogether free from growth.

It would appear then that complete desiccation or exposure for five minutes to a temperature of 75° C. alike suffice to kill these bacilli.

Measurements were made of the bacilli in dried and stained specimens from active colonies in gelatine plate cultivations. The single bacilli measure in length from 0·6 to 1·6 micromillimetres (some examples are much longer, up to 4 and 5 m.m.), the dumb-bells from 1·2–1·6. The thickness of each sort is about 0·5–0·6 micromillimetres.

II.—*Experiments on Animals with diseased Lung-tissue of Human Pneumonia Cases, and with Culture of the Bacillus obtained from Human diseased Lung.*

Human lung-juice inoculated into guinea-pigs.

Experiments on Guinea-pigs.—(*a.*) With a few drops of lung-juice from a severely inflamed human lung, I, on June 25th, inoculated, subcutaneously in their inguinal regions, four guinea-pigs. One of these guinea-pigs was found ill on June 27th,—being very quiet, its coat rough, its breathing very rapid. It was found dead in the morning of 28th June. On post-mortem examination there was, at the seat of inoculation, slight discoloration; the lymph-gland near the seat of inoculation was congested; the spleen small; kidneys and liver congested; both lungs severely congested, large portions in a state of red hepatisation. The other three guinea-pigs did not show any distinct illness; certainly none of them died.

(*b.*) With a few drops of lung-juice of a severely inflamed portion of human pneumonia-lung I inoculated on June 26th four guinea-pigs, each in the inguinal subcutaneous tissue. On July 3rd one of them was found dead. *Post-mortem.*—The lymph glands near the seat of inoculation were red and swollen; the connective tissue around was congested; the peritoneum inflamed; the spleen small; the right heart distended by a blood-clot; there was pleuritis with much fibrinous exudation; and both lungs were extremely inflamed, the greater part of one and a considerable part of the other being almost in a state of red hepatisation.

From the heart's blood of the guinea-pig (*a.*) dead on June 28th and also from the heart's blood of guinea-pig (*b.*) dead July 3rd, a large

* Specimens in my possession, taken from gelatine cultures several weeks old, show all their bacilli swollen and hyaline, and in each of them a central dark granule (spherical or oval in shape) which has stained readily with ordinary dyes.

number of cultivations were made in and on gelatine, and in and on Agar, in tubes; but no growth of any kind appeared in them. Cover-glass specimens, however, made of the lung-juice of both guinea-pigs, revealed the presence of the bacilli chiefly as dumb-bells, in size and general aspect identical with those already described as obtained from the human lung-juice. At the same time a large number of test-tubes containing gelatine, as well as test tubes containing Agar mixture, were inoculated with juice of the inflamed lung of both guinea-pigs, and in each of these tubes a successful crop was raised of the same bacilli as had been obtained in similar fashion from the human pneumonia-lung. As a matter of fact, too, from both samples of human lung used for the inoculation of these guinea-pigs successful cultivation of the bacillus described above had been obtained by precisely similar processes.

Guinea-pigs lung-juice inoculated into guinea-pigs.

For further testing whether the inflamed lung-tissue of the guinea-pig (*a*.) dead on July 3rd did actually contain the virus, inoculations were made with its lung-juice in two other guinea-pigs. One of these was found very ill on July 5th; coat rough, breathing very rapid, the animal huddled up, and its eyes sunken. It was found dead in the morning of July 6th. *Post-mortem.*—Right heart distended by blood clot; peritonitis; spleen small; kidneys and liver congested; both lungs severely inflamed. From the lungs of this animal successful crops of the bacillus were raised; and cover-glass specimens made of the fresh lung-juice revealed the presence of the same bacilli. From the heart's-blood no bacillary growths could be obtained by culture.

From this series of experiments we learn, then, that by inoculation into guinea-pigs of matter of the human pneumonia-lung, illness and death is produced in a small per-centage of these rodents; their illness being a severe form of pneumonia, associated with congestion of the liver and kidneys; the spleen, however, remaining small. This absence of the spleen enlargement, taken together with the absence of the bacilli in the blood after death, shows this induced illness to be different from septic infection as commonly understood.

In three other series of experiments with guinea-pigs the same positive results were obtained. In each of the three, two guinea-pigs were inoculated with a few drops of lung-juice of a guinea-pig dead of the disease [produced either by inoculation with blood of mice dead of the same disease, or produced by particular samples of bacon, as will be shown later on], and in each series one guinea-pig died with pronounced disease of both lungs, the right ventricle distended by blood clot, and the spleen small.

Mice inoculated with human lung-juice.

Experiments on Mice.—With a droplet of human lung-juice I inoculated four mice on July 6th. All four animals were ill on July 7th; coats rough; animals very quiet and drowsy; breathing rapid; eyes small. One of these mice was dying the same evening, and was found dead on the morning of July 8th. A second mouse was found dead on the morning of July 9th. The other two mice,—though still very quiet, unwilling to move, and with rough coats on July 9th,—got gradually better and had quite recovered by July 14th.

On post-mortem examination of the above two dead mice the following conditions were found: in mouse (1),—spleen enlarged and dark; liver and kidneys show hæmorrhagic spots; pericardium contains sanguineous fluid; both lungs very much inflamed, almost solid; mouse (2), peritonitis: the intestines much distended by mucus; liver congested; spleen slightly enlarged and dark; both lungs show very pronounced inflammation. In the lung-juice and in the spleen bacilli were present in considerable numbers; they were morphologically of exactly the same kind as described above, and, as cultivations proved, were also in other respects identical with them (Fig. 7, B).

Mice inoculated with lung-juice of experimental mice and guinea pigs.

In addition I have to mention that two mice inoculated with lung-juice of a guinea-pig, and other two mice inoculated with lung-juice of a mouse dead after inoculation with the juice of the human inflamed lung, became ill in the same way. The majority of them (three out of

four) died, and on *post-mortem* both lungs were found much inflamed, the spleen large and dark; in one case also the intestine was distended by mucus.

We see, then, from these experiments that mice are more susceptible to the disease than guinea-pigs; and further, that while in both species of rodent the lungs are chiefly affected, in mice the spleen it in addition found dark and enlarged.

Inoculation of rodents with cultures of the pneumonia bacillus.

The next step was to study the action on animals of the bacillus isolated from the human lung. For this purpose cultures in alkaline broth were made from a pure cultivation, and a few drops of them were injected subcutaneously into guinea-pigs and mice.

[Rabbits were not used in the above series of experiments for inoculation with lung-juice, on account of a great mortality from a not-ascertained cause obtaining during last summer amongst them. But later on, in the autumn, I tried the effect of inoculation of them with cultures of the bacillus by subcutaneous or intravenous injections. On subcutaneous injection of a drop or two of the active broth culture into the groins of two rabbits, a tumour could be felt here in each animal after about 48 hours. This tumour, however, at about the end of the week, began to subside. In one rabbit, which died on the eighth day, no disease was ascertainable in the viscera of the chest or abdomen, though about the seat of inoculation (or more correctly speaking, between the fascia and the muscles of the thigh) there was purulent matter. The second rabbit died after three weeks with nothing abnormal visible at or about the seat of inoculation. There was in this animal a small amount of sanguineous pericardial exudation, and hyperæmia of the lungs; the spleen was small, and the liver congested. I must, however, state that about the same time (October) there still persisted the great mortality of which I have spoken amongst other rabbits not subjected to experiment and in these, as well as in those dead during the summer, hyperæmia of the lungs and liver was ordinarily present. In addition I have injected a considerable amount, about $\frac{1}{2}$—1 cc., of active broth culture of the bacillus obtained from the human lung directly into the vein of the ear of the rabbit. Four rabbits were thus experimented upon, but they remained well. From these facts I am disposed to infer that rabbits are unsusceptible to this disease.]

Guinea-pigs inoculated with the cultures.

On September 22nd I inoculated, subcutaneously into the groins of two guinea-pigs, a few drops of a milky mixture of the bacillus growth (on gelatine) in salt solution.

After 24 hours the guinea-pigs were noticed to be quiet; after 48 hours very quiet, unwilling to move; they were huddled together, and their coats were rough. At the seat of inoculation a slight swelling could be felt in each instance. On September 26th they were much livelier; in each a firm corded swelling could be felt at the site of inoculation. The swelling gradually disappeared, and by the beginning of October the animals appeared normal.

On September 27th two additional guinea-pigs were inoculated with a broth culture 24 hours old: a few drops of this being introduced subcutaneously into the groin. On September 28th the animals were quiet; on September 29th they were very quiet, huddled together and unwilling to move; and when they were induced to move they were very unsteady and shaky. Their coats, too, were rough.

On September 30th they were better; coats smoother, and they were livelier. In a few days they had quite recovered.

Other two guinea-pigs subsequently inoculated from an Agar culture three months old showed no disturbance of their normal condition.

Mice inoculated with cultures.

The results of the inoculation of mice proved very positive, inasmuch as subcutaneous inoculation produced illness in all, severe illness and death in the large majority of the animals. It is unnecessary to detail all these cases, their number being considerable: I mention therefore only general conclusions. Cultivations in broth, cultivations on gelatine,

and cultivations on Agar mixture distributed in sterile salt solution, were used, and the results were uniform, viz., after 24 hours the animals were found ill; they were huddled up, their coats rough, eyes small, breathing rapid; they were quiet and drowsy and unwilling to move. Next day, or within a day or two, some of them were found worse or already dead; few recovered. Death may take place between 24 hours (or even 20 hours) and 72–96 hours; it may be even longer delayed. On *post-mortem* examination the following is found: at the seat of inoculation there is great congestion; the spleen is dark and enlarged; in half the cases the intestines are distended with mucus; the kidneys and liver are congested; the lungs in all cases are in a state of more or less severe inflammation, larger or smaller portions being in a state of red hepatisation.

The mice that did not succumb showed inflammation of the skin at the seat of the inoculation, leading in some cases to sloughing of the skin hereabouts; but eventually healing was effected. Three such mice, after the lapse of two months, were re-inoculated with broth culture, which was at the same time tested on two control mice. The control mice died with the symptoms of pneumonia, while the above three mice remained alive; they were quiet the second day, but were quite lively and again normal on the third day.

Cultivations were made of the heart's-blood (Fig. 7, C) of the dead mice, of their diseased lung-tissue, and of the spleen in several instances, and in all the bacillus was recovered very easily; in plate cultivations of these materials the colonies came up in large numbers. Cover-glass specimens too made of the fresh blood (Fig. 2, p.), lung, and spleen showed the bacillus pneumoniæ present in considerable number. In no case did I find in the resulting cultivation of the heart's-blood, of the spleen, or of the diseased lung, any other organism except the bacillus pneumoniæ.

Mice fed with cultivation.

Several experiments were made on mice by *feeding* them on bread soaked in broth cultures, and with gelatine cultures of the bacillus pneumoniæ. Out of 10 mice thus fed two died after 48 hours, one was found dying on the 6th day, and one on the 13th day. In all of these there was pronounced pneumonia of both lungs, amounting to red hepatisation of considerable portions of lung-tissue. Also, there was enlargement of the spleen. In the two mice dead after 48 hours the intestines were found much inflamed and filled with blood and mucus.

By cultivation of heart's-blood of these mice no bacillary growth was obtained, but from their lung-juice numerous colonies of this bacillus were obtained.

Mice and guinea-pigs inoculated with blood and lung-juice of experimental rodents.

Inoculations of a large number of mice were made with heart's-blood and lung-juice taken from guinea-pigs and from mice, dead of the disease after inoculation with material of the human pneumonia cases other than the lung, and by these means also fatal results were obtained in the great majority of cases. The *post-mortem* examination in such cases showed the disease of the lungs and spleen, but only in half of their number was the intestine found distended with mucus. Cultivations made in gelatine from the heart's-blood and spleen of some of these mice, yielded very numerous colonies of the bacillus pneumoniæ.

Two guinea-pigs were inoculated with heart's-blood and lung-juice of a mouse dead of the disease induced in it by inoculation with juice of a human pneumonic lung, and two other guinea-pigs with heart's-blood and lung-juice of a mouse dead of the disease induced by inoculation of cultivation of the bacillus pneumoniæ. Of each set, one guinea-pig died, on the 3rd and 4th day respectively. Both lungs in both animals were found extremely inflamed, but the spleens were not enlarged.

The cultivations obtained from the heart's-blood, lung-tissue, or spleen, of mice dead of their induced disease, were tested on other mice by subcutaneous inoculation of broth cultures, and these proved to be as virulent as those obtained from the human lung; but I have noticed that by repeated subculture the virulence becomes less, inasmuch as a fatal termination of the disease becomes rarer; but the animals nevertheless show distinct illness.

General Conclusions from the above Experiments.

I think I am justified in drawing the following conclusions:—

(1.) In the diseased lung of the Middlesbrough pneumonia cases there were present in large numbers short bacilli, that are not Friedländer's bacillus nor the diplococcus pneumoniæ of Fränkel and Wiechselbaum, but which upon cultivation and inoculation into rodents appear to be a definite species, distinctly different from either; I therefore call this bacillus the *Bacillus Pneumoniæ*.

(2.) Neither Friedländer's bacillus nor the diplococcus pneumoniæ of Fränkel and Wiechselbaum was obtainable from this human pneumonic lung by cultivation.

(3.) The lung-juice of this pneumonia when inoculated in guinea-pigs, and especially when inoculated into mice, produced an acute disease, of which the chief and constant anatomical lesion was severe inflammation of the lungs. Mice were more susceptible than guinea-pigs.

(4.) Artificial cultures of the "bacillus pneumoniæ" from the human lung or from the blood of an experimental mouse proved very virulent to mice, less so to guinea-pigs. In mice these bacilli produced the same fatal disease as mentioned above, with conspicuous pneumonia.

(5.) The blood and lung-juice of mice and of guinea-pigs dead of the disease experimentally induced by the materials from the several above-recorded sources, produced on inoculation into other mice and guinea-pigs severe pneumonia terminating fatally.

(6.) In all experimental animals dead of the induced disease, the lung-juice (in mice also as a rule the heart's-blood and the spleen) contained the bacillus pneumoniæ.

(7.) By feeding mice with artificial cultures of the bacillus, the same pneumonia was produced, but not in so large a proportion of experimental animals as by inoculation.

III.—*Experiments with certain Samples of Bacon.*

An interesting series of experiments was carried out with certain samples of bacon sent by Dr. Ballard from Middlesbrough. Of these samples, the history of which and other points connected with them will be found in Dr. Ballard's report, some produced no result upon mice fed with them, while other samples produced severe pneumonia when administered as food, both in guinea-pigs and mice.

Feeding experiments on rodents.

On June 29th I fed with a particular sample of bacon* four guinea-pigs and four mice. On June 30th all the mice were quiet, huddled together, their coats rough; one was particularly noticed breathing very rapidly, and as being very ill. It died towards the evening. On post-mortem examination, both lungs were found very much congested, the spleen was slightly enlarged and showed some very dark patches. Inoculation of culture tubes with heart's-blood proved negative. On July 2nd the three remaining mice were still ill, but looked better. The guinea-pigs did not show any alteration in their condition.

On July 7th I fed 11 mice and four guinea-pigs with samples of the bacon (three mice and two guinea-pigs with sample No. 3†; four mice and two guinea-pigs with sample No. 4‡; four mice with sample No. 5§).

Positive results.

On July 9th all the mice and two of the guinea-pigs looked ill; hair rough, the animals very quiet, unwilling to move, eyes almost closed,

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* Captured June 27. Case XII., Addendum A.
† Captured July 5. Case XVII., Addendum A.
‡ Captured July 5. Case XV., Addendum A.
§ Another sample from same lump of bacon, captured later, viz., on July 5.

breathing rapid. On the evening of this day the condition of some grew worse, and in the morning of July 10th one mouse (fed with No. 3) was found dead. One mouse was dying (fed with No. 4), and it died during the day. One guinea-pig was dead (fed with No. 4). The other guinea-pig died on July 16th, with pneumonia of both lungs.

On post-mortem examination, in both mice the lungs were very much congested, and the spleen was slightly enlarged and dark. In the guinea-pigs both lungs were very much inflamed, the greater portion of the lower half in a state of red hepatisation; kidneys and liver congested; spleen not enlarged; right heart distended by clot.

The bacillus obtained from tissues of experimental animals

Cultivations were made in gelatine tubes from the lung-tissue of the dead mice and guinea-pigs, and the bacillus pneumoniæ was obtained in all the experimental tubes. With the lung-juice of one guinea-pig I inoculated two mice. On July 11th, *i.e.*, after 24 hours, one of the mice looked decidedly ill; coat rough, breathing rapid, eyes small, animal drowsy. In the evening this animal died. On post-mortem examination both lungs were found much congested, spleen dark and slightly enlarged. Successful cultivations of the bacillus pneumoniæ were obtained from the heart's-blood of this mouse.

Another of the mice fed on July 7th with No. 3 sample of bacon, died on July 11th. In this case also both lungs were found much congested. With the lung-juice of this mouse I inoculated two guinea-pigs.

induced disease transmissible from rodent to rodent.

On July 13th one of these guinea-pigs was found dead; both lungs were extremely inflamed, whole lobes being in a state of red hepatisation; spleen not enlarged. With the lung-juice of this guinea-pig I inoculated other two guinea-pigs. One of these animals was found dead on July 15th. Post-mortem examination showed pericarditis with sanguineous exudation; both lungs much inflamed; slight pleuritis; spleen small; right heart distended by blood clot. Successful cultivations of the bacillus pneumoniæ were obtained from the lung of this guinea-pig.

In addition to the above, a considerable number of mice were experimented upon by feeding with various samples of bacon sent by Dr. Ballard, and in a large proportion of them illness of the same character was produced. In about 50 per cent. death ensued between 24 hours and 72 hours. On post-mortem examination, the lungs were found inflamed, the spleen more or less enlarged, and in some cases the intestine was congested and filled with and distended by mucus. Pathologically, the lung lesions, together with morbid changes in other viscera, showed the induced disease to be identical with that which had been produced in guinea-pigs and mice, alike by inoculation of the juice of the human pneumonic lung and by inoculation of the bacillus pneumoniæ obtained by culture from the diseased lung of man and from the experimental animals. Further, it appeared that from mice and guinea-pigs infected by the bacon with pneumonia, the same bacillus pneumoniæ was recoverable by cultivation.

Lest it be inferred, in view of subsequent accidental infection of my stock of rodents recorded below, that the positive results of these feeding experiments were due not to virus contained in the bacon but to extension in common-place fashion among the general stock of rodents at the Brown Institution, of the pneumonic disease previously induced there in certain experimental animals, I lose no time in stating that no such explanation is admissible. At the date, and during progress, of the above feeding experiments, there was no extension whatever of pneumonic disease from animal to animal such as was observed later in the year. Not only were the experimental animals of June and July kept separate from all other animals at the Brown Institution, but each experimental series of rodents was kept separate from other series. Moreover, none but experimental animals were at this time attacked by pneumonic disease; and further, when successful results were obtained, the interval of time between experimental feeding or inoculation and the appearance of the induced disease was of fairly equal duration in all cases. There can be no question, then, in my judgment, that certain samples of this Middlesbrough bacon did really contain a virus which produced in guinea-pigs and mice fed with such

samples, disease of the lungs in no way distinguishable from that induced in other rodents by inoculation of lung-juice obtained from the bodies of persons dead of Middlesbrough pneumonia.

From two samples (Nos. 3 and 4) of the bacon, however, which had been kept for three months, I have since made a large number of gelatine-plate and gelatine-tube cultivations, and have isolated hereby several species of micrococci and several species of bacilli; but without obtaining the bacillus pneumoniæ. Mice, too, fed with these samples at the same time that the cultivations were made from them, did not suffer any illness. It was now found, as regarded several other samples of bacon which had two or three months previously produced illness and death of mice fed with them, that they had lost the power of similarly infecting these animals; and further, it was found that when these same samples were used for inoculation of culture media no growth of the bacillus was obtainable.

Accidental Infection of Animals.

An unexpected and highly interesting confirmation of the inference as to causative relation of the bacillus described in the previous pages to pneumonia is supplied in the following observations :—

During the months of November and December 1888 and January 1889 there occurred at the Brown Institution numerous deaths among mice and guinea-pigs which though not the subjects of experiment, had been kept in the same room with the mice and guinea-pigs that were inoculated and fed with cultures of the bacillus pneumoniæ. Two dozen mice and about 40 guinea-pigs died, and on post-mortem examination there were found in them appearances absolutely identical with those found in the animals that had been inoculated with cultivations of the bacillus pneumoniæ. In both mice and guinea-pigs there was extensive pneumonia, pleural and occasionally pericardial exudation; in some there was peritonitis, and the intestines were inflamed and filled with sanguineous mucus. In the mice the spleen was dark and enlarged, but in the guinea-pigs the spleen was not altered.

With the juice of the inflamed lung-tissue and with heart's-blood of some of these mice, cultivations on gelatine were made. From the heart's-blood of some of them colonies of the bacillus pneumoniæ, but no other organisms were obtained; from the heart's-blood of others no organisms whatever were obtained. But in all samples of lung-tissue tested very large numbers of colonies of the bacillus pneumoniæ made their appearance on the inoculated gelatine. Morphologically and culturally these bacilli were absolutely identical with those obtained from the human pneumonic lung. With these cultures, and with subcultures from them, healthy mice were inoculated, and again the result was the same as that obtained on inoculation of material from cultures of the bacillus pneumoniæ from the human lungs.

During January 1889 three monkeys died at the Brown Institution. The animals had for a few days previous been very ill; their skin felt hot, they had very rapid breathing, and were sleepy and drowsy. On post-mortem, the lungs showed lobar pneumonia; whole lobes, well mapped off from the rest, were found hepatised. Microscopic sections through the diseased parts showed a precisely similar condition to that observed in the human pneumonic lung; viz., all blood vessels distended blood; the alveolar cavities containing a network of fibrine threads, and between round cells and a few red blood discs. On most careful search, neither in the lung nor in any other organ was there any trace of tubercle to be found.

Cover-glass specimens made of this diseased lung-tissue revealed numerous organisms identical with the bacillus pneumoniæ. Upon subculture on gelatine, made with minute particles of the diseased parts of the lung-tissue, there appeared, after two or three days, on the gelatine innumerable colonies, which later on and in further subculture possessed characters identical with those of bacillus pnemoniæ. No other organisms were present in these cultures.

Inoculations of mice with cultures of the organism from the monkey's lung produced death of some of them; the post-mortem appearances being identical with those produced in mice after inoculation with the bacillus pneumoniæ from the human lung. From these mice, cultivations from the heart's-blood and the tissues of the diseased lung were made, and colonies of bacillus pneumoniæ were obtained in large numbers.

ADDENDUM C.

Manufacture of Bacon in Middlesbrough.

The remarkable coincidence between the area of the epidemic prevalence and the area supplied with bacon by the bacon-makers in Middlesbrough and its practical limitation to this area, together with the fact that the vera causa of the malady was a specific and hitherto unrecognised bacillus, which at the least may be said to have been found in bacon prepared in Middlesbrough (although not confined to such bacon apparently); and in addition the apparent fact that the pneumonia of the kind prevalent in 1888 (whose most marked characteristics were its communicability and epidemicity) was something novel in the town's experience, raises an interesting and not unimportant question. How came the specific bacillus to be introduced into the place, and how came the bacon to be infected? Although I am not in a position to solve these questions satisfactorily, it may be useful to state some facts which may be thought of as supplying data towards its solution.

There are four establishments in the town of Middlesbrough in which American salted pork is converted into the pale (mild) sort of bacon preferred by the labouring classes in this part of England, and whose trade is confined to the town of Middlesbrough and the adjacent Local Board districts. One of these establishments very much surpasses the other three in the extent of its manufacturing business. I designate the establishments T., U., W., and X. (see p. 219). Three of these factories are situated in the northern section of the town and one in the older part of one of the southern sections. Speaking generally, the process is the same in all four establishments, and consists in washing the pork, draining off some of the water, and drying off some that has been absorbed. But there are peculiarities about each establishment which require pointing out. The plans in Addendum to this report, Numbers 1, 2, 3, and 4, will assist in understanding them.

Plan 1 relates to the establishment T. All parts of the process are carried on within a building erected upon what would otherwise be the backyard of the dwelling-house. The ventilation of the building is by a door opening into the street and by two small openings in the drying-room. The washing-tank (*a*) is of wood, and close to it within the building is a gully grating (*b*) into which the water from the washing tank is discharged at a distance of about one foot. Beneath the gully grating is a trap of the consturction shown at p. , from which a pipe drain (shown by dotted line) runs to a covered man-hole (*c*). This drain receives in its course pipe drains from two other houses. The construction of the man-hole situated at the junction of two passages at the rear of dwellings

is shown in the sectional plan. It was found to be constructed, as were all the man-holes in the older part of Middlesbrough (p. 168), with a receiver or cesspit at the bottom which was said to be cleaned out from time to time, but which at the time of my visit was filled with filthy black mud. The cover of the man-hole had in it a small ventilating grating. Into this man-hole was discharged the sewage of 18 other houses—21 houses and the factory in all. The drying-room was warmed by a coke stove in the customary manner.

Plan 2 relates to establishment U. Part of the process here, such as the washing and draining, is conducted in the open air, and part (drying mainly) in covered places where there is a free passage of air, viz., the drying-shed, and what is designated in the plan the "bacon store." The washing-tanks of stone or cement discharge over a bricked surface, furnished with a small grated inlet, beneath which is a short (1 foot) irregular descent to what stands for a trap, but which, as is seen by the vertical sketch in the plan, is no trap at all, but merely a receiver for filth, into which the drain from the scullery sink of the dwelling-house discharges itself, and which is in direct communication with the public sewer. The washed pork is after draining hung up in the drying-shed to dry spontaneously, or in damp weather with the aid of a coke fire. The various sources of foul effluvia in this yard and about the drying-shed and bacon store, viz., privies, an undrained stable, a manure heap (large at the time of my visit), are shown upon the plan; the privy pails and refuse from the ashpits have all to be emptied through the factory-yard.

Plan 3 relates to establishment W. This is a very small affair, the business being a limited one, and having been only established about one-and-a-half years at the time of my visit. The manufacturing premises are below the street level; in fact in the cellar of the house beneath the shop—a room at the rear of the cellar being used as a drying-room and store-room, and heated on occasion by a small coke stove in the customary manner. The cellar used for washing and draining the pork, and as a store for the salted pork from America, is very badly and irregularly paved with brick. It communicates freely with the drying-room at its rear. A moveable tub is used for the washing, and there is sunk in the floor of the cellar an iron vessel (*a*), like an ordinary washhouse boiler, to receive any water that may be spilled or fall from the draining pork. Attached to the side wall of the cellar, and raised about 4 feet from the floor, is a sink (*b*) into which the washing water from the washing tub is baled for discharge into the sewer. It was necessary to raise it thus high because the floor of the cellar is a good way below the level of the street sewer. From this sink there passes a 3-inch sanitary pipe bent at an elbow (cross-section *c*). which runs by a short route directly into the sewer without a trap of any kind. The cellar and drying-room were thus in direct atmospheric connexion with the public sewer. At the time of my visit there was a strong stream of sewer air rising from the sink opening into the cellar. The occupant of the place informed me that at times the stink from this source has pervaded not only the cellar and drying-room, but also the house and shop.

Plan 4 relates to establishment X. It consists of a covered building having a series of chambers all communicating, and having an open door at one end. There are in one of these chambers four washing tanks or vats of wood, and between each pair of vats on either side wooden racks, on which the washed pork is laid to drain. At the time of my visit each of these pairs of tanks were discharged by an opening at the bottom into an open channel shown in the sectional plan, into which fell also the drainings from the racks between the vats. From the channel on one side an underground pipe conveyed the water (as shown by the dotted line) to a drain inlet in a yard near the warehouse, and on the other side to a similar drain inlet in another yard that was nearer to it. At each of these inlets was a trap of the usual sort used in Middlesbrough (p. 169), but the drain pipes were not made to discharge above the gully grating, but at a depth of 2½ feet below the grating. The top of the

gully-trap indeed, about 12 inches wide, did not reach the surface grating by more than this distance, the intervening part being a sort of brick shaft very irregular, the surface of which was coated with a slimy greyish-black material or deposit. It was into this shaft that the drain pipe entered above the water level of the trap. Much the same arrangement existed at the drain opening in the other yard. The receiver of the trap contained a filthy deposit. This same shaft received also a drain from an urinal in the yard. In order to intercept particles detached from the pork by the washing process, there was a grating placed at the spot where the channel beneath the draining racks communicated with the drain pipes. On these gratings (which were necessarily cleared from time to time) I found a quantity of fatty matter, a sample of which I transmitted to Dr. Klein: his report to me upon it was that it was "*very* poisonous" At this establishment the ordinary coke fires are not used, but the drying-room is heated by hot-water pipes. There are two stories to the drying-room with good arrangements for ventilation. Some bacon is smoked here: but with smoked bacon I am not just now concerned.*

Now, given the presence (whatever may have been its source or origin) of the specific bacillus in the town sewers and in the deposits of the manhole cesspits, and assuming that this infective organism can be conveyed by moist air and so infect drains and the contents of traps of deposit such as are in use universally in the Middlesbrough district (there is strong suggestion that it was conveyable by the moist air issuing from the infected lungs of the sick), it is easy to see how all these four establishments (equally with houses into which emanations from sewer drains or traps of deposit may enter) were open to the infection of any bacon made in them from salted pork of any kind. And pork has, it would seem, of all kinds of animal food that is eaten, a special faculty of fostering and attracting to itself pathogenic organisms;—as is exhibited in the case of the cysticercus cellulosæ and the trichina spiralis, and in the case of such microscopic organisms as the Welbeck bacillus, and here again at Middlesbrough as the "bacillus pneumoniæ."

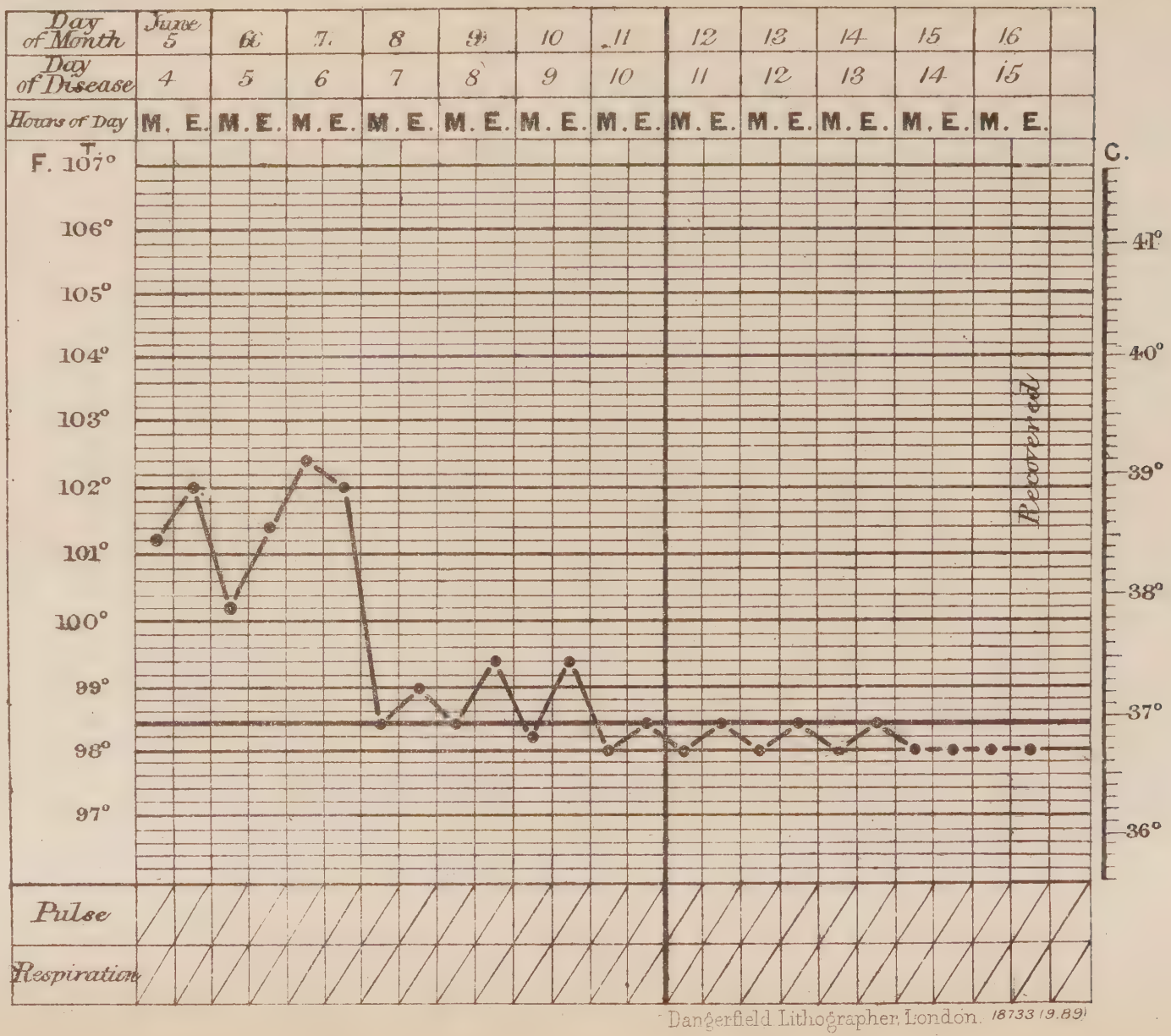
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* Shortly after I left Middlesbrough these premises underwent a thorough process of cleansing and disinfection, and necessary improvements in the drainage arrangements were made to the satisfaction of the Medical Officer of Health.

NORTH RIDING INFIRMARY.

Temperature Chart No. I. Case XXVIII. p. 311.

Name. G. D. Age 45 yrs. Disease Epidemic Pneumonia.

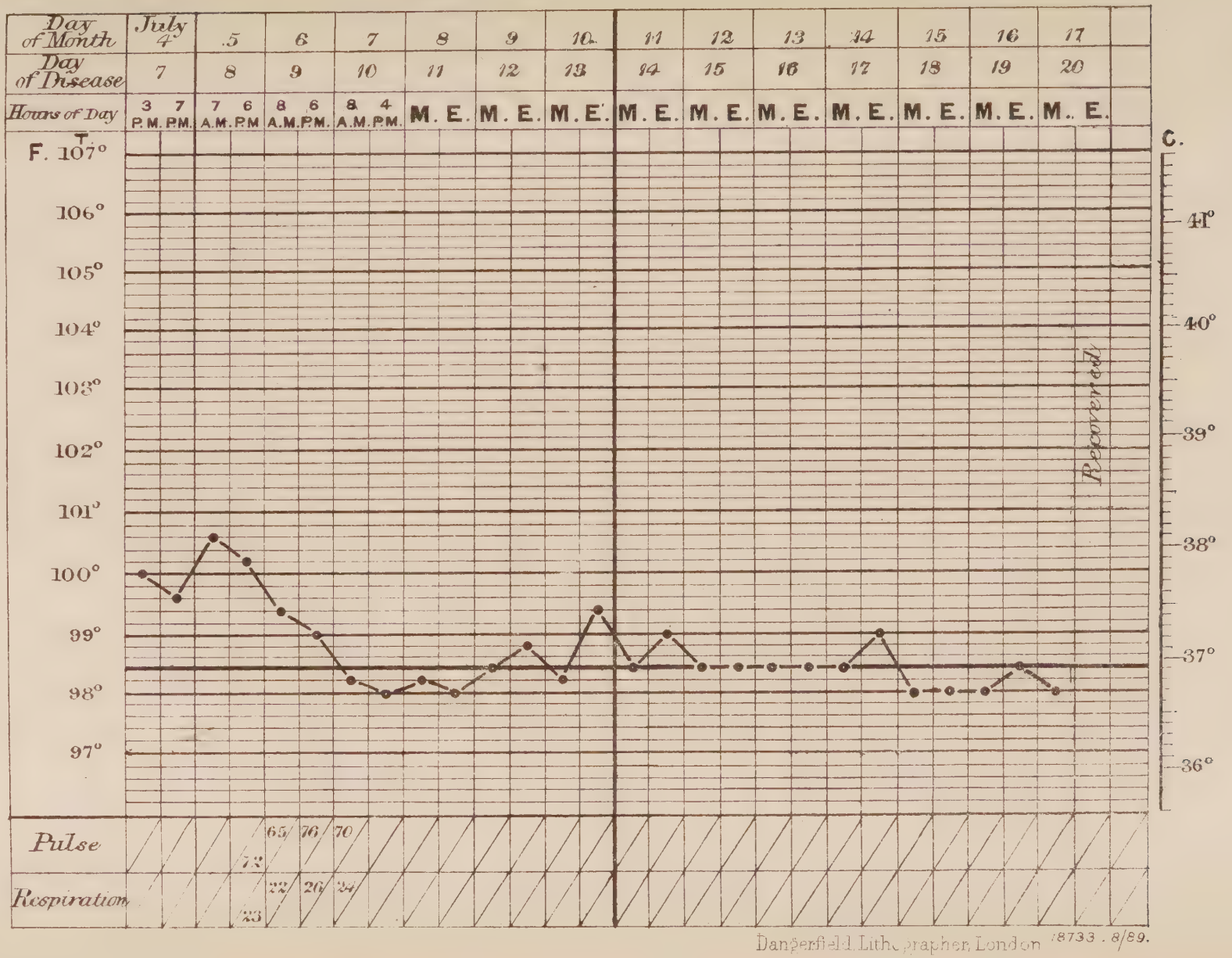


Dangerfield Lithographer, London. 18733 (9.89)

NORTH RIDING INFIRMARY.

Name. R. W. Age 24 yrs. Disease Epidemic Pneumonia.

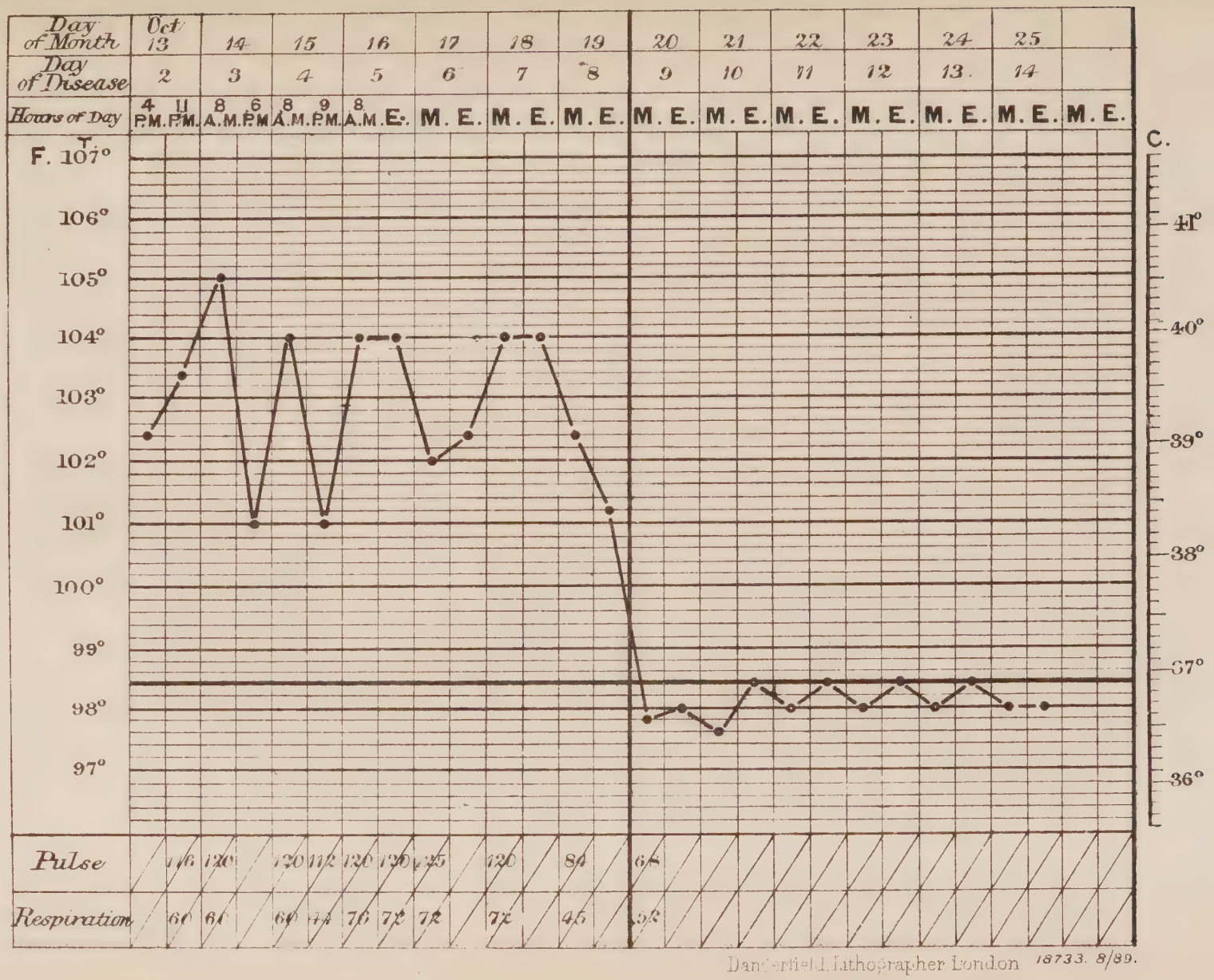
Temperature Chart No 2. Case XXIX. p. 311.



Dangerfield Lithographer, London 8733 . 8/89.

Name. J. P. Age 21 yrs Disease Epidemic Pneumonia.

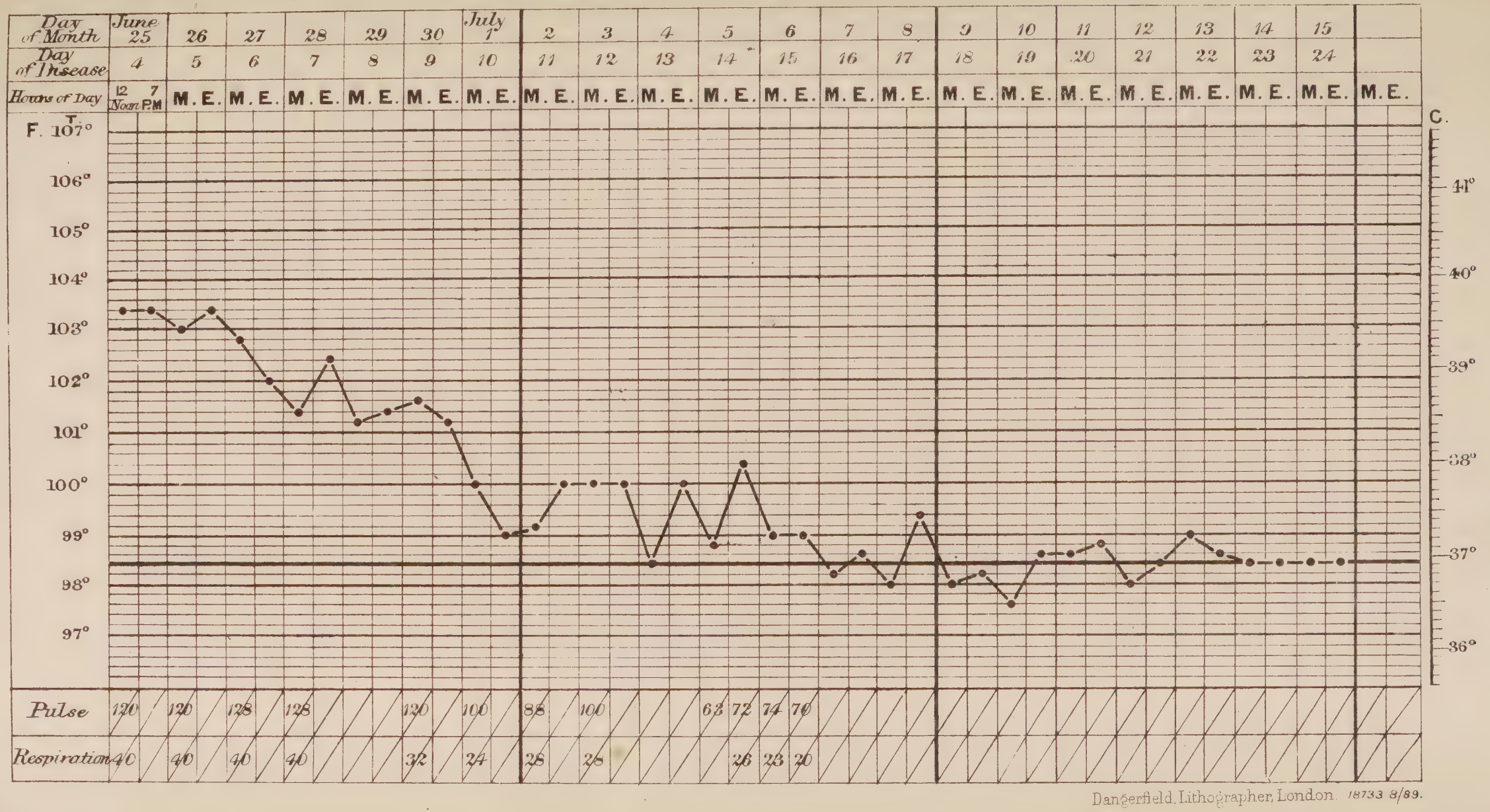
Temperature Chart No. 3. Case XXX. p. 311.



Dangerfield, Lithographer London 18733. 8/89.

Temperature Chart № 4 – Case XXXI. p. 312.

Name. A. T. Age 25 yrs. Disease Epidemic Pneumonia.

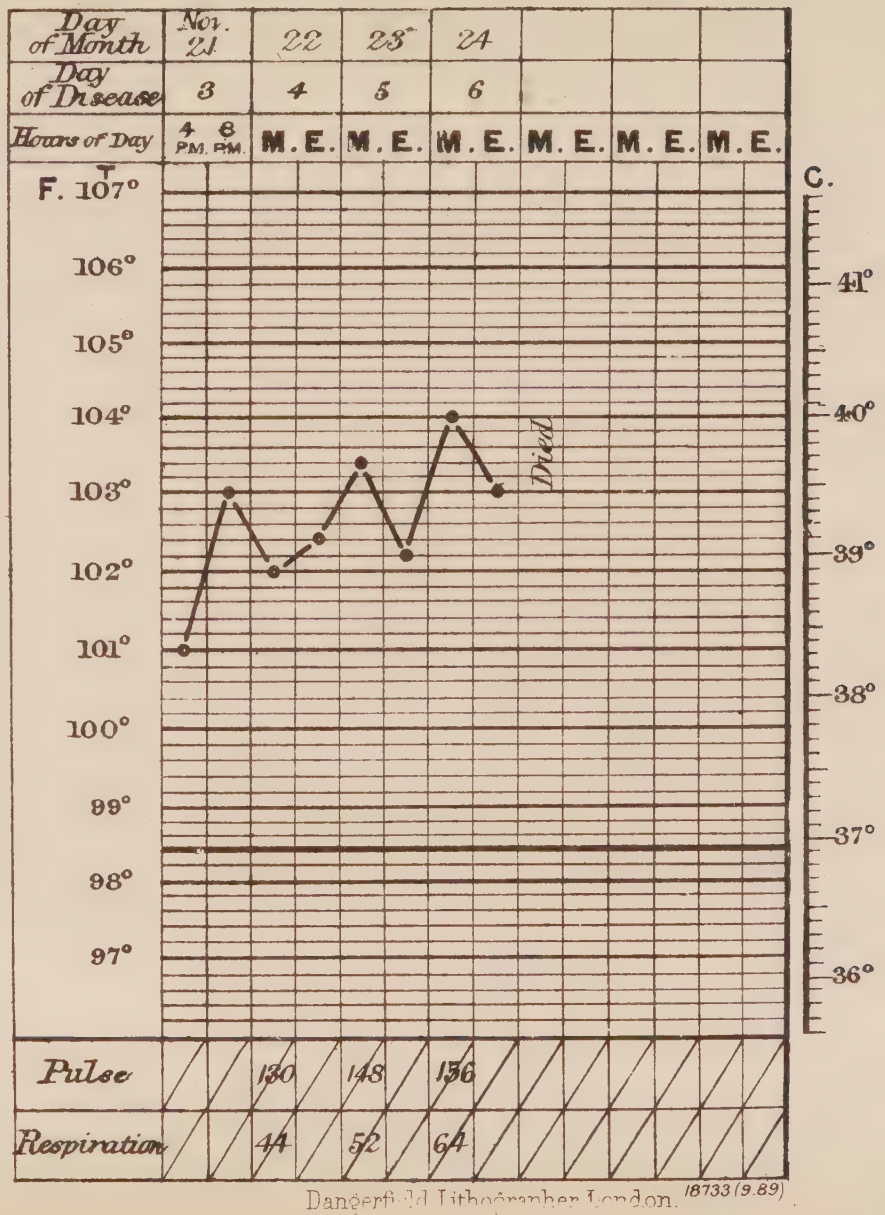


Dangerfield, Lithographer, London. 18733 8/89.

NORTH RIDING INFIRMARY.

Name R.W. Age 25 yrs. Disease Epidemic Pneumonia.

Temperature Chart No. 5. Case XXXIV. p. 313.



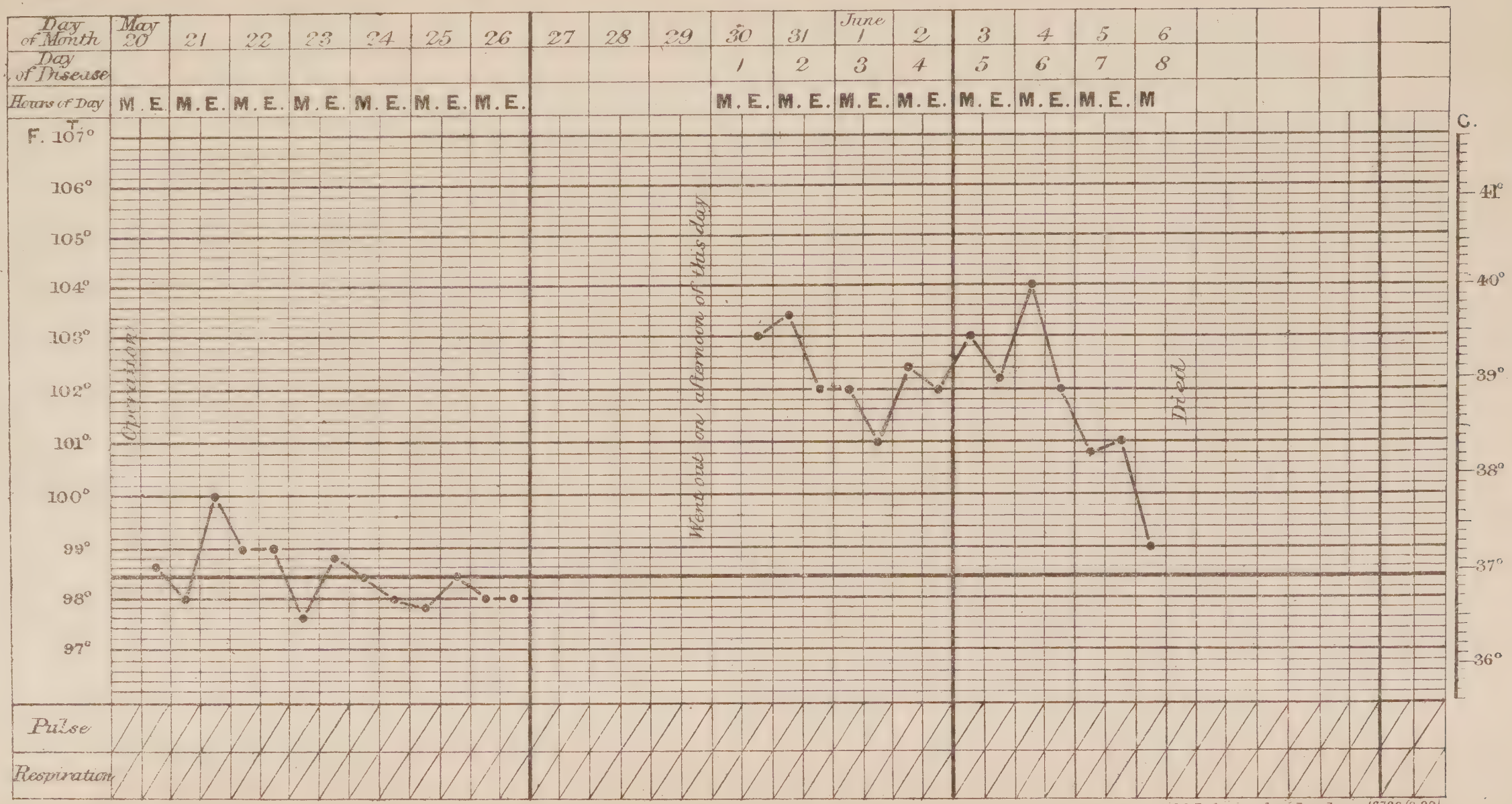
Dangerfield Lithographer London. 18733 (9.89)

Temperature Chart No 6. see p. 231.

NORTH RIDING INFIRMARY.

"A PREVIOUSLY HEALTHY MAN — TEMPERATE — ADMITTED FOR RADICAL CURE OF HERNIA" — ADMITTED MAY 14.

Name. T. M. *Age* 34 yrs. *Disease* Epidemic Pneumonia.

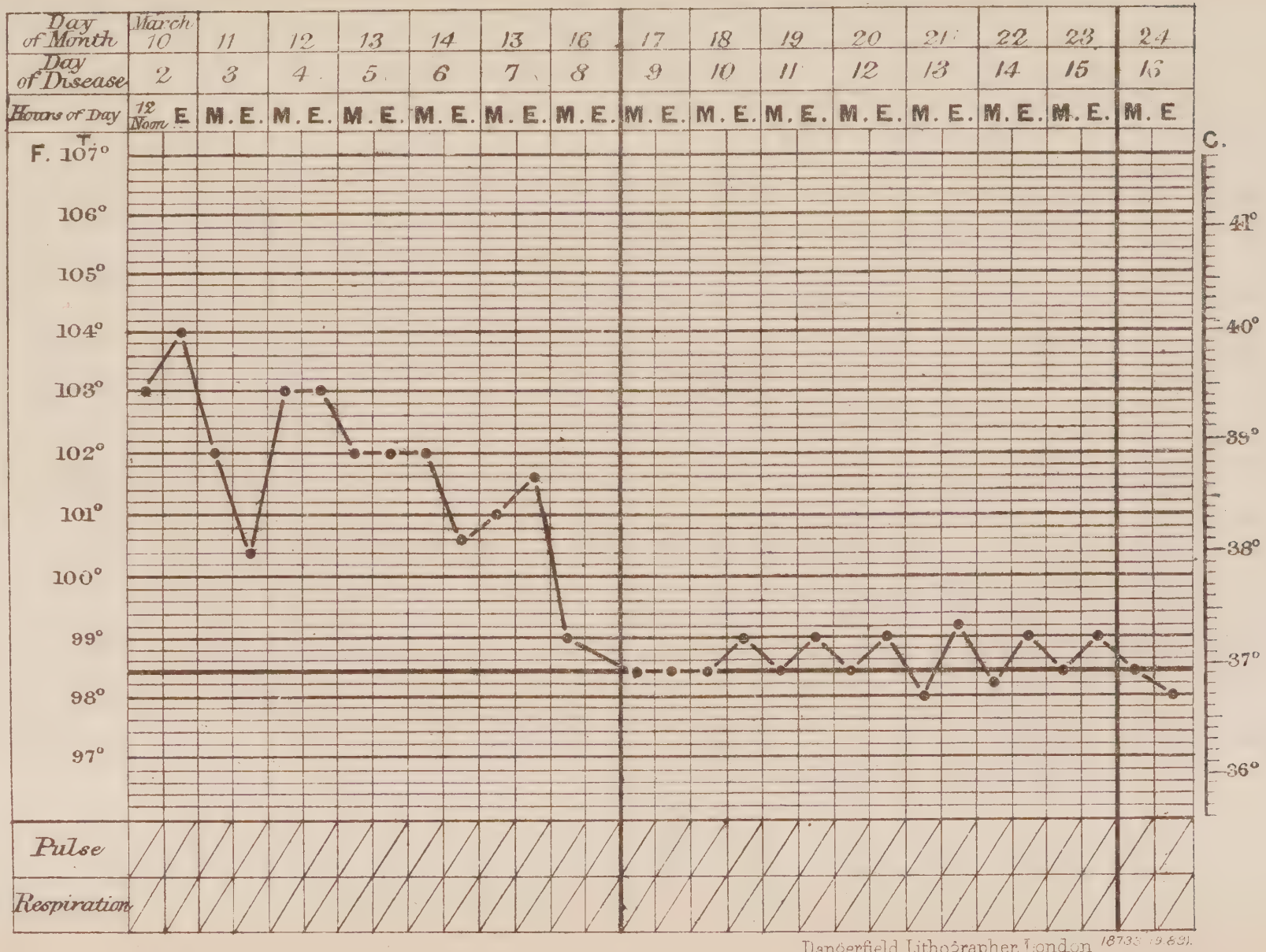


Dangerfield, Lithographer, London. 18733 (9 89).

NORTH RIDING INFIRMARY.

Name. W. O. *Age* 32 *yrs.* *Disease* Epidemic Pneumonia.

Temperature Chart No 7.

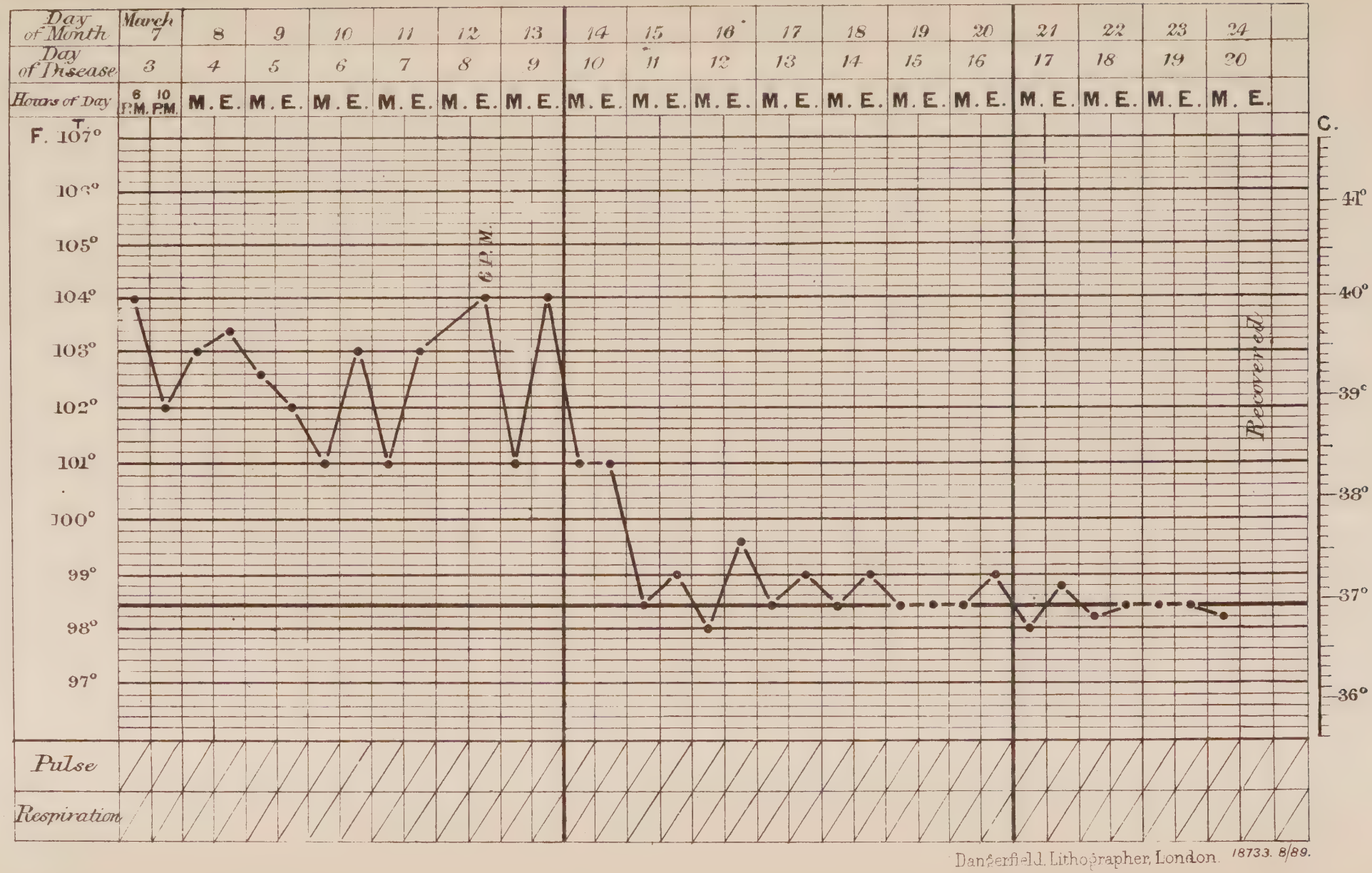


Dangerfield, Lithographer, London 18733 (9.83).

Temperature Chart No. 8.

DOUBLE PNEUMONIA VIOLENT DELIRIUM UNTIL CRISIS.

Name. A.B. *Age* 30 yrs. *Disease* Epidemic Pneumonia



Danfer field, Lithographer, London. 18733. 8/89.

Temperature Chart No 9.

NORTH RIDING INFIRMARY.

"DURING CONVALESENCE, SYNOVITIS OF RIGHT KNEE OCCURRED WITH ELEVATION OF TEMPERATURE. THE CONTENTS OF THE JOINT BECAME PURULENT. THE JOINT WAS FIRST TAPPED; THEN OPENED & DRAINED".

Name J. D. *Age* 32 yrs *Disease* Epidemic Pneumonia.

Day of Month	March 14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	April 1	2	3
Day of Disease	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Hours of Day	3 P.M E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.

T. F. 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97°

C. 41° 40° 39° 38° 37° 36°

Temperature

Pulse

Respiration

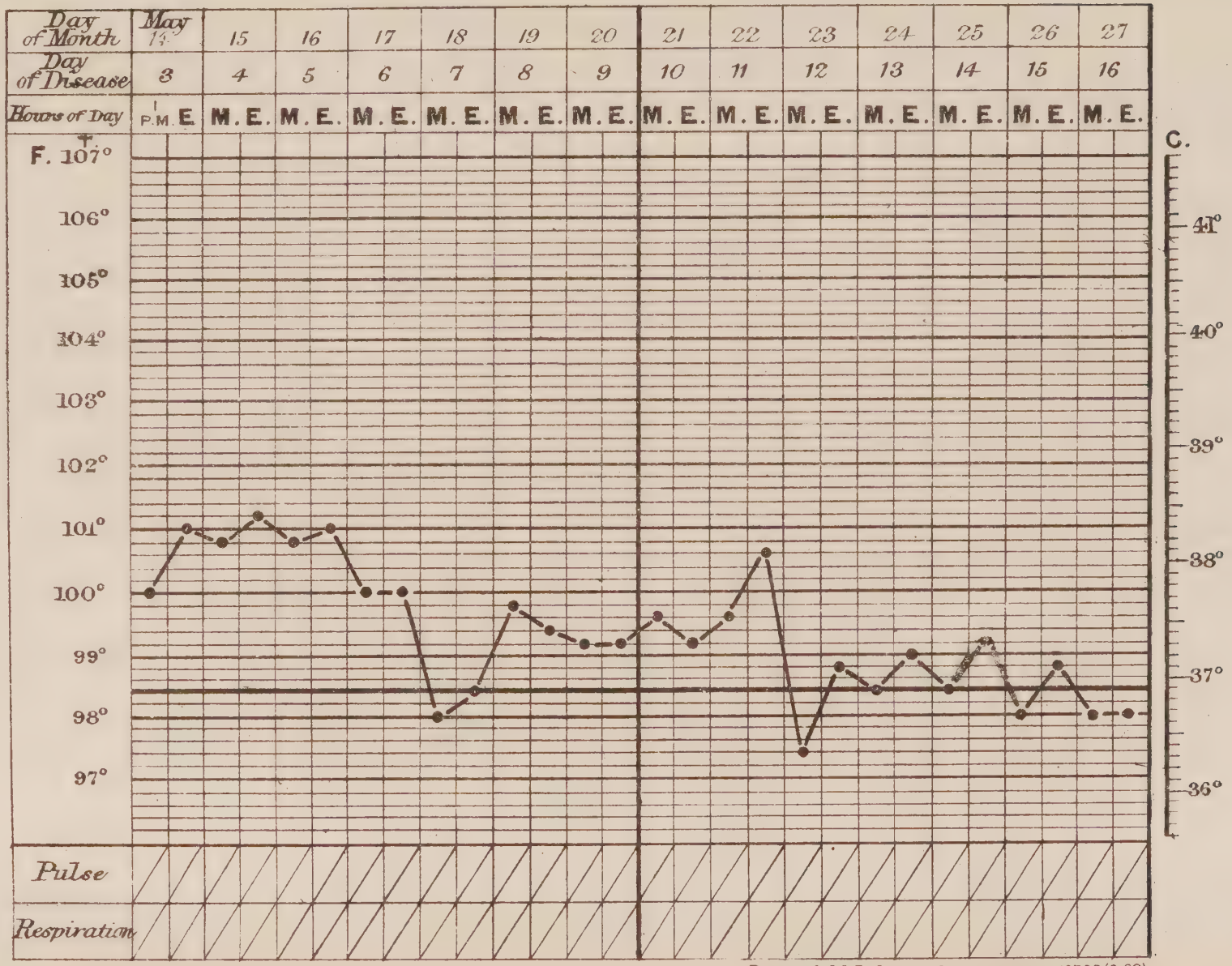
Dangerfield, Lithographer, London. 18733 (3.89)

NORTH RIDING INFIRMARY.

"VIOLENT DELIRIUM FOR SEVERAL DAYS UNTIL CRISIS."

Name. J. Mc G. *Age* 30 *yrs* *Disease* Epidemic Pneumonia.

Temperature Chart
No 10.



Dangerfield, Lithographer, London. 18733(9.89)

To face p. 328.

Temperature Chart No II.

NORTH RIDING INFIRMARY.

"ON MAY 28, DURING CONVALESCENCE, RIGHT LEG BECAME SWOLLEN & PAINFUL & ON EXAMINATION FOUND PLUGGING OF RIGHT FEMORAL ARTERY."

Name. J. W. *Age* 45 yrs. *Disease* Epidemic Pneumonia.

Day of Month	May 15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	June 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Day of Disease	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Hours of Day	12 Noon E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.	M. E.

F. 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97°

C. 41° 40° 39° 38° 37° 36°

Recovered

Pulse

Respiration

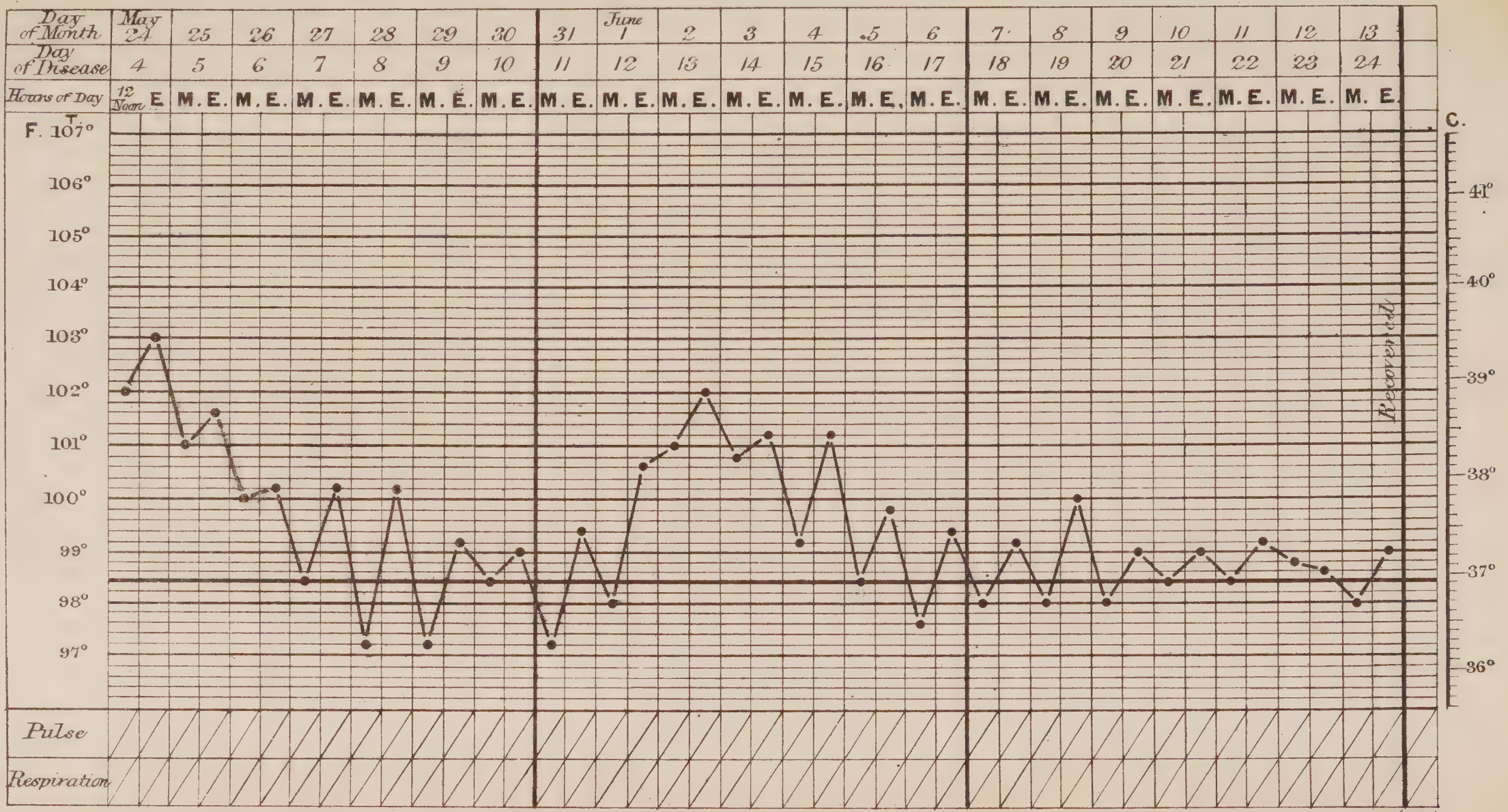
Dangerfield, Lithographer, London (6733(683))

Temperature Chart No 12.

NORTH RIDING INFIRMARY.

"LEFT CASE FIRST AFFECTED .MARKED DELIRIUM FROM COMMENCEMENT & CONTINUED ABOUT 10 DAYS - RIGHT LUNG ATTACKED ABOUT JUNE 1ST."

Name A. P. Age 25 yrs. Disease Epidemic Pneumonia.



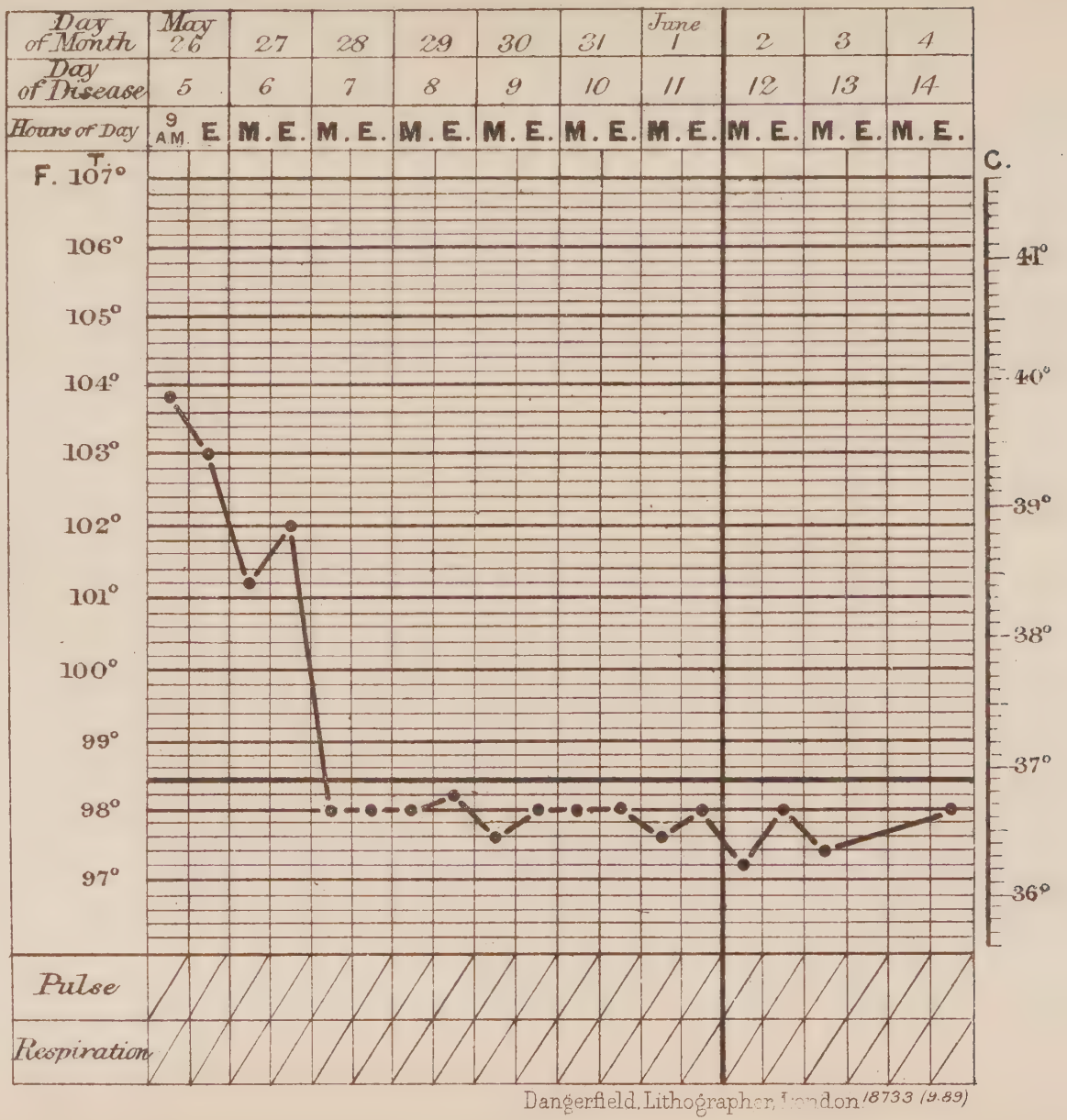
Dangerfield, Lithographer, London. 18733(8.89)

NORTH RIDING INFIRMARY.

"NO DELIRIUM. EARLY & SPEEDY CONVALESENCE."

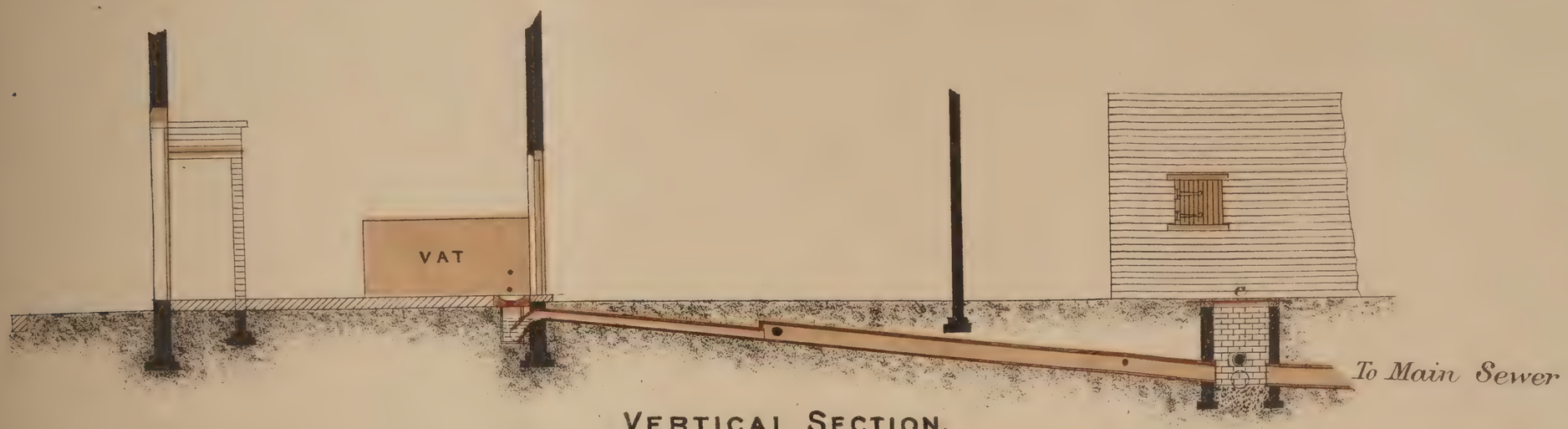
Name. H. E. *Age* 17 yrs *Disease* Epidemic Pneumonia.

Temperature Chart No. 13.



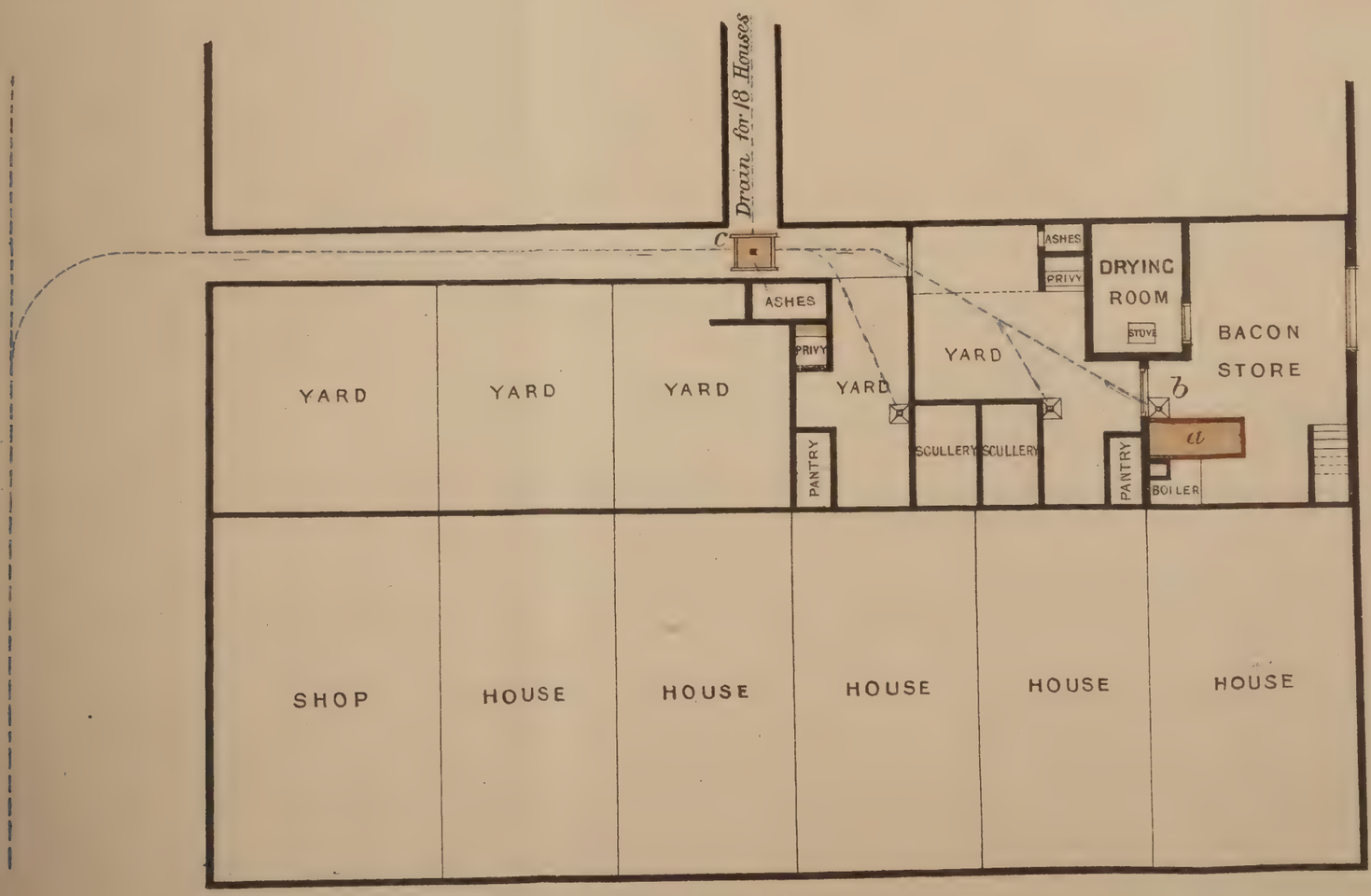
Dangerfield, Lithographer, London. 8733 (9.89)

PLAN I—T.



VERTICAL SECTION.

Scale 8 Feet to an inch

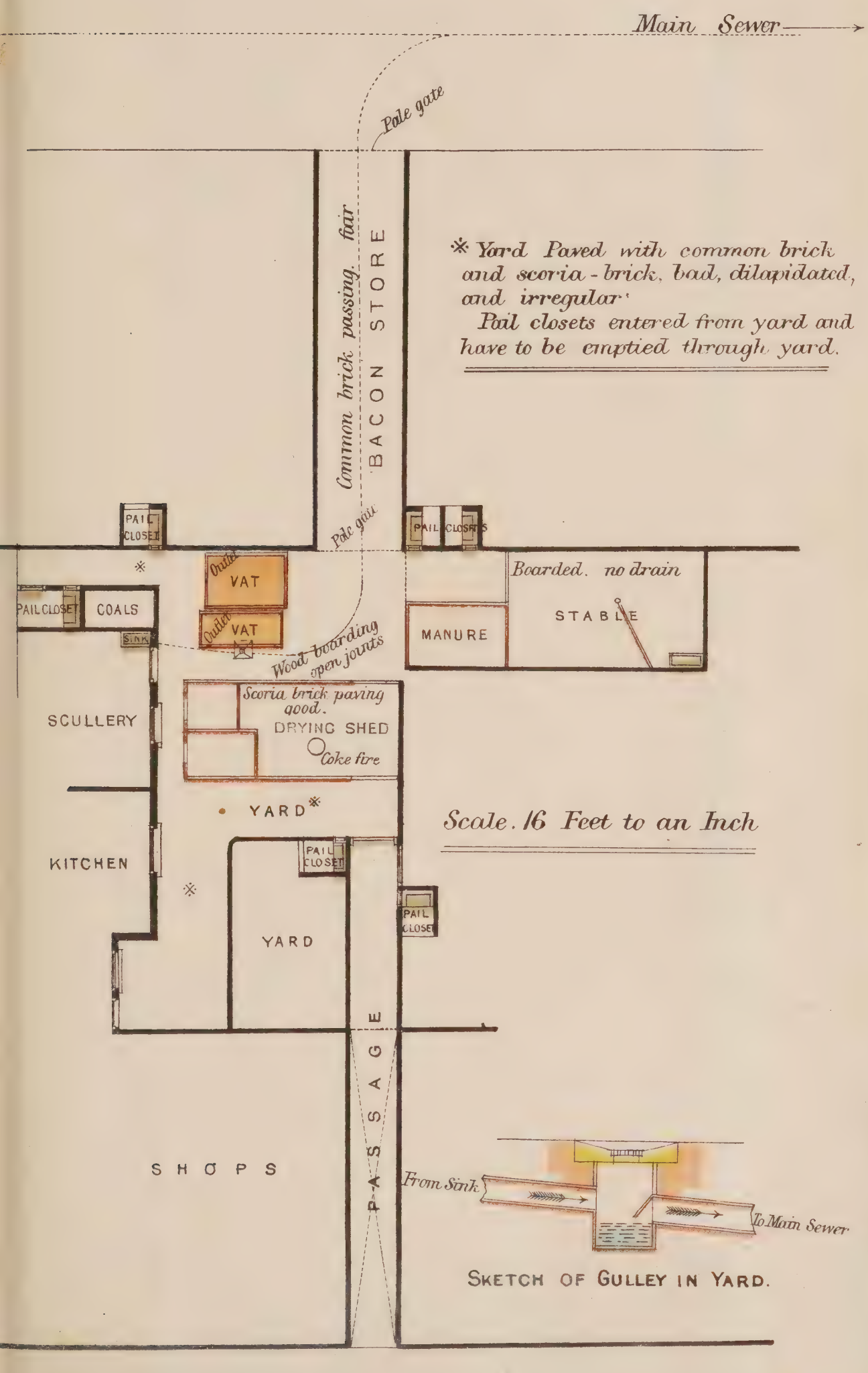


GROUND PLAN.

Scale, 16 Feet to an Inch.

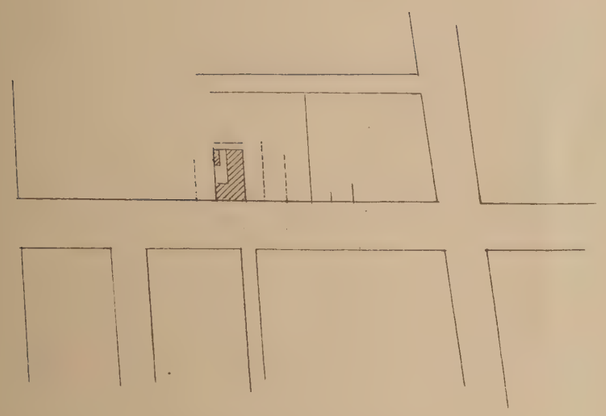
DANGERFIELD LITH 22, BEDFORD ST COVENT GARDEN. 18054 4/89

PLAN 2-U.



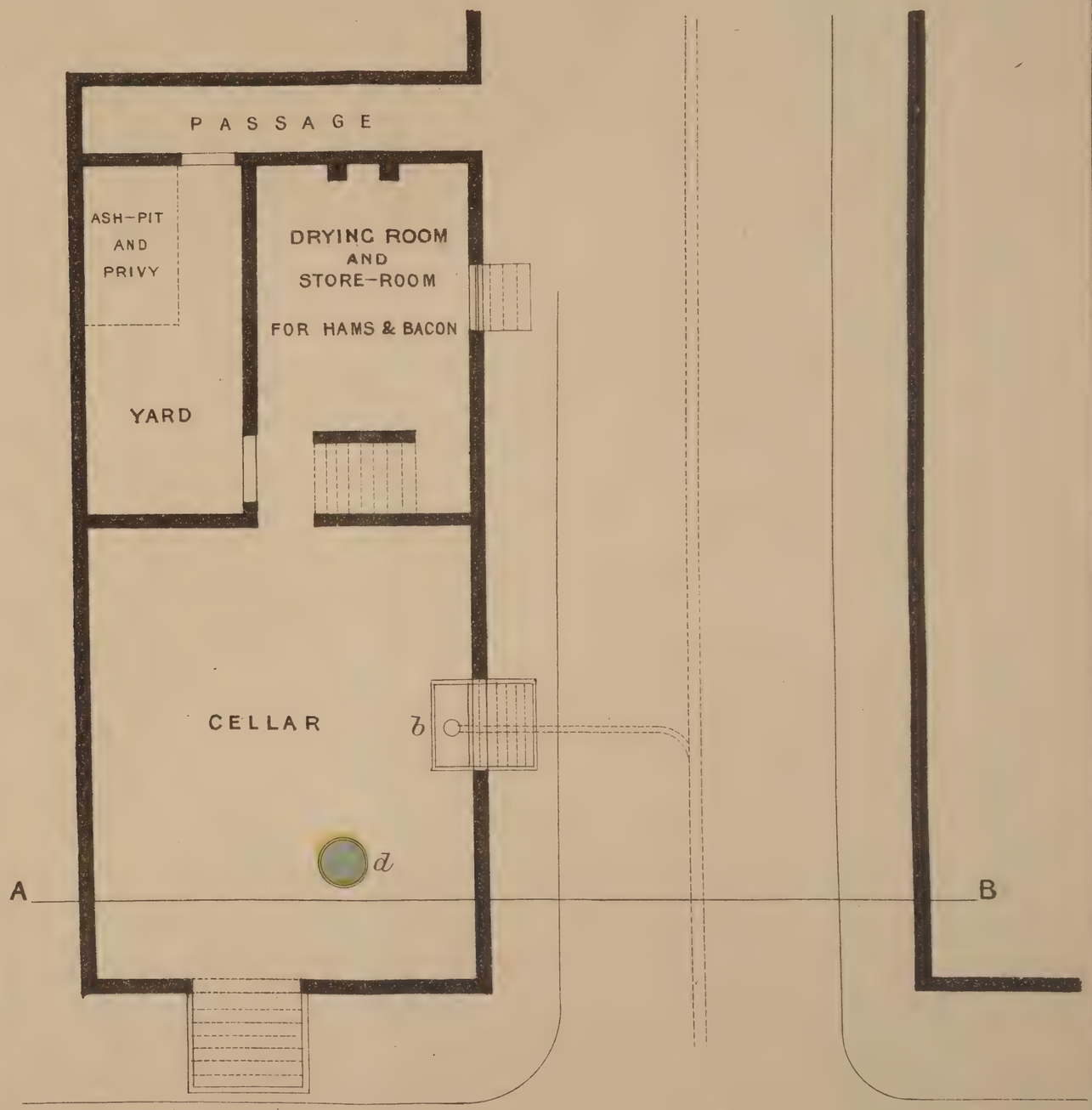
DANCERFIELD LITH 22 BEDFORD ST COVENT GARDEN. 18469 4/89

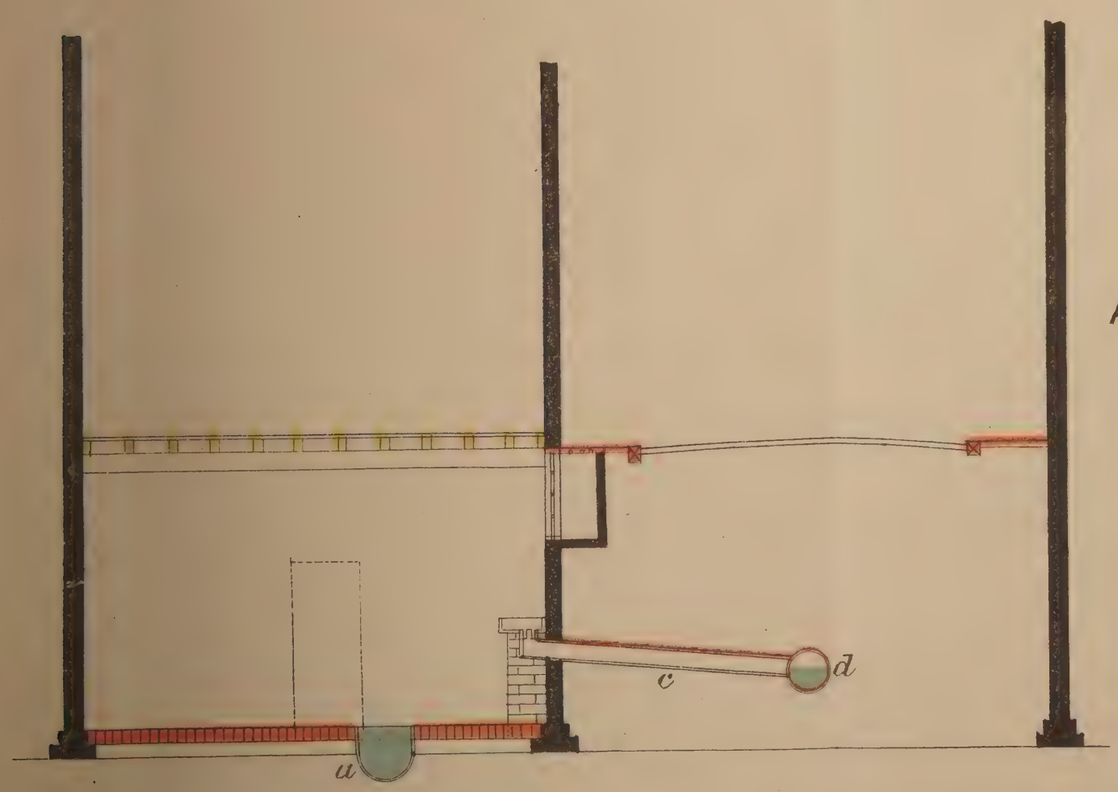
PLAN 3–W.



BLOCK PLAN

176 ft = One Inch.



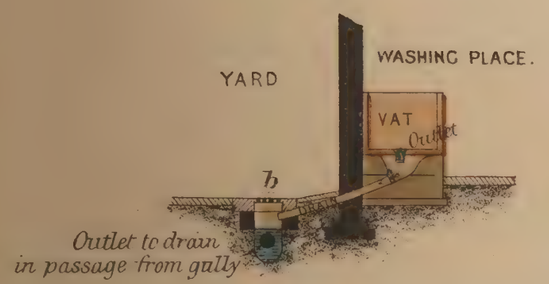


CROSS SECTION, THROUGH LINE A. B.

Scale; 8 ft = One Inch.

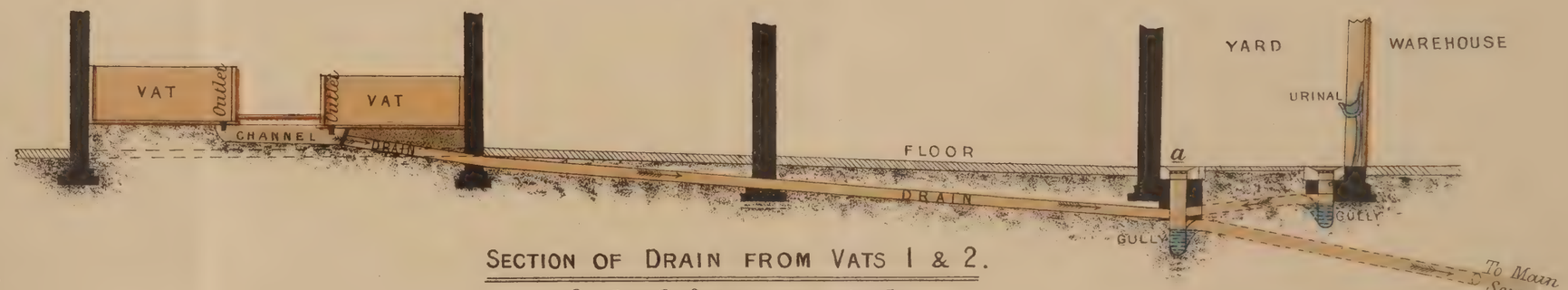
DANCERFIELD LITH 22, BEDFORD ST COVENT GARDEN. 18054 4/89.

PLAN 4 – X.



SECTION OF DRAIN FROM VATS 3 & 4.

Scale; 8 feet to one inch



SECTION OF DRAIN FROM VATS 1 & 2.

Scale 8 feet to one inch.



PLAN

Scale; 8 feet to one inch.



W.C. Hopper Pan Trap and Separate Water Supply Cistern.

DANCER. LITH. 22. BEDFORD ST. COVENT GARDEN 1865 4/89.

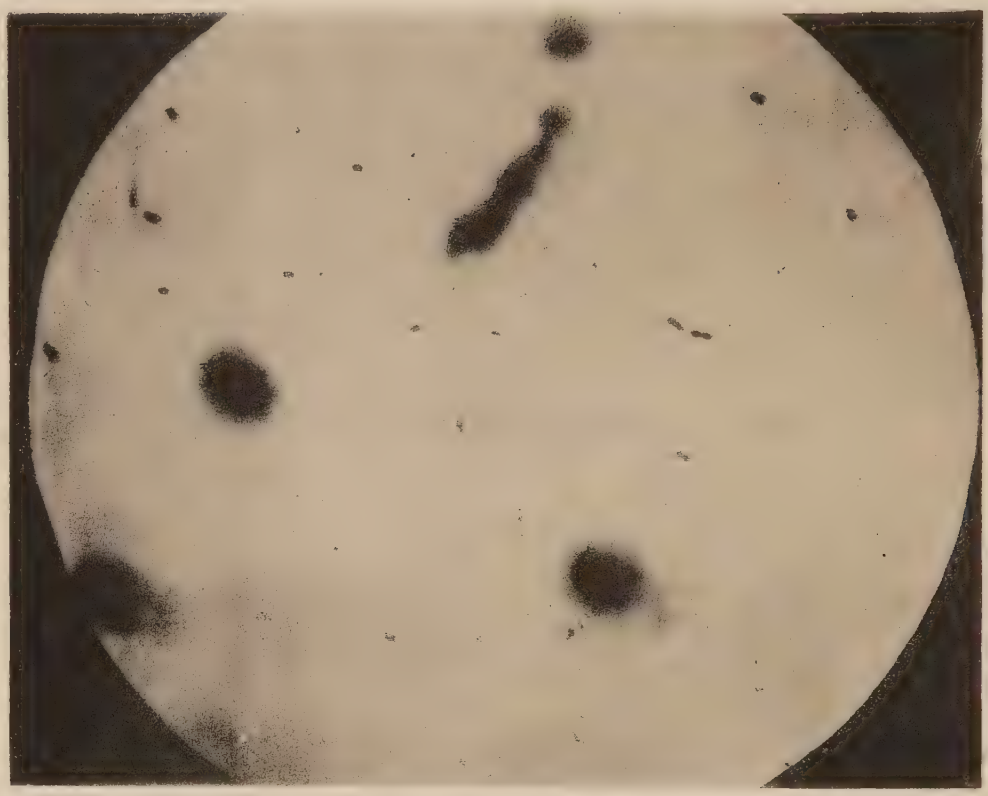


Fig. 1.

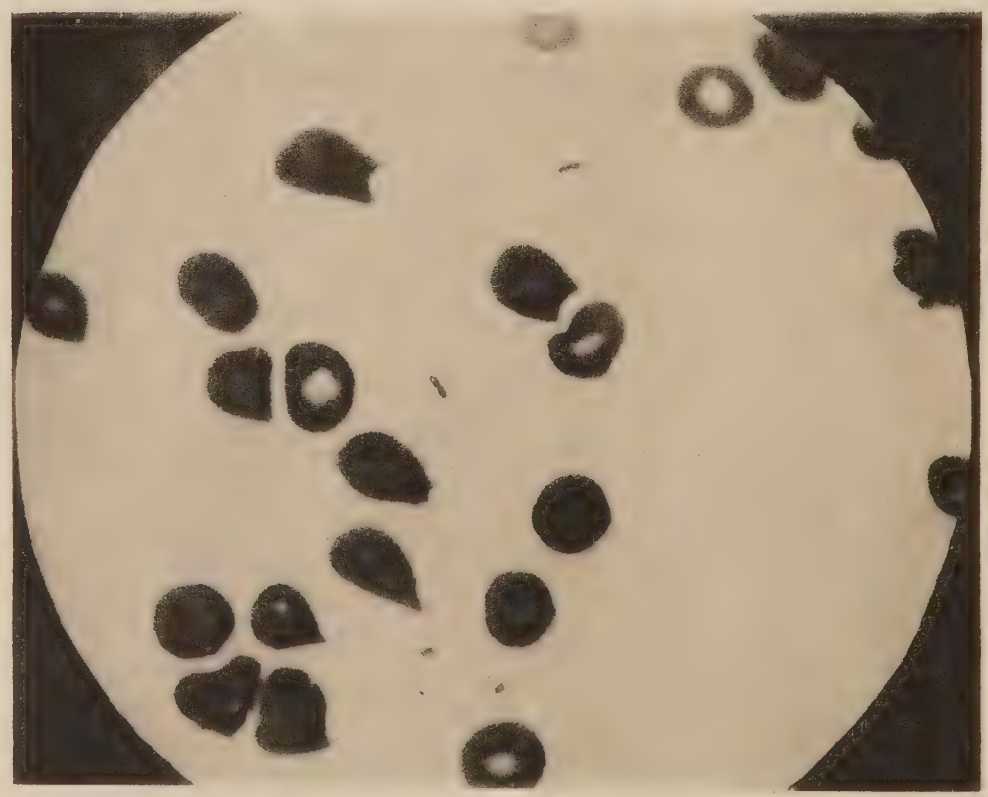


Fig. 2.

MIDDLESBROUGH PNEUMONIA.

FIG. 1.

Preparation from lung juice of fatal pneumonia case. Numerous bacilli, singly or as dumb-bells.

[Magnifying power about 1,150.]

FIG. 2.

Preparation from blood of a mouse, dead after inoculation with material of a subculture of the *bacillus pneumoniæ*. Red blood discs, and among them two single bacilli and two dumb-bell forms.

[Magnifying power about 1,150.]

MIDDLESBROUGH PNEUMONIA.

FIG. 3.

Preparation from a pure subculture of *bacillus pneumoniæ* on nutrient gelatine.

[Magnifying power about 1,150.]

FIG. 4.

Similar preparation from a colony of the organism appearing in plate culture.

[Magnifying power about 1,150.]

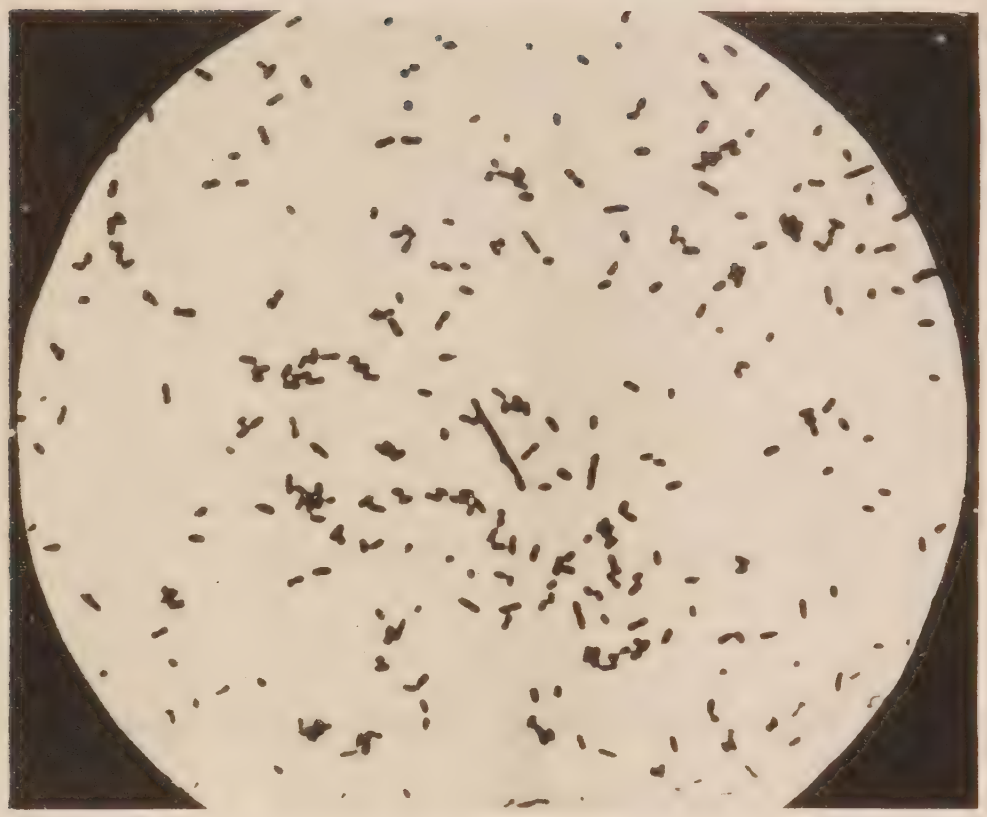


Fig. 3.

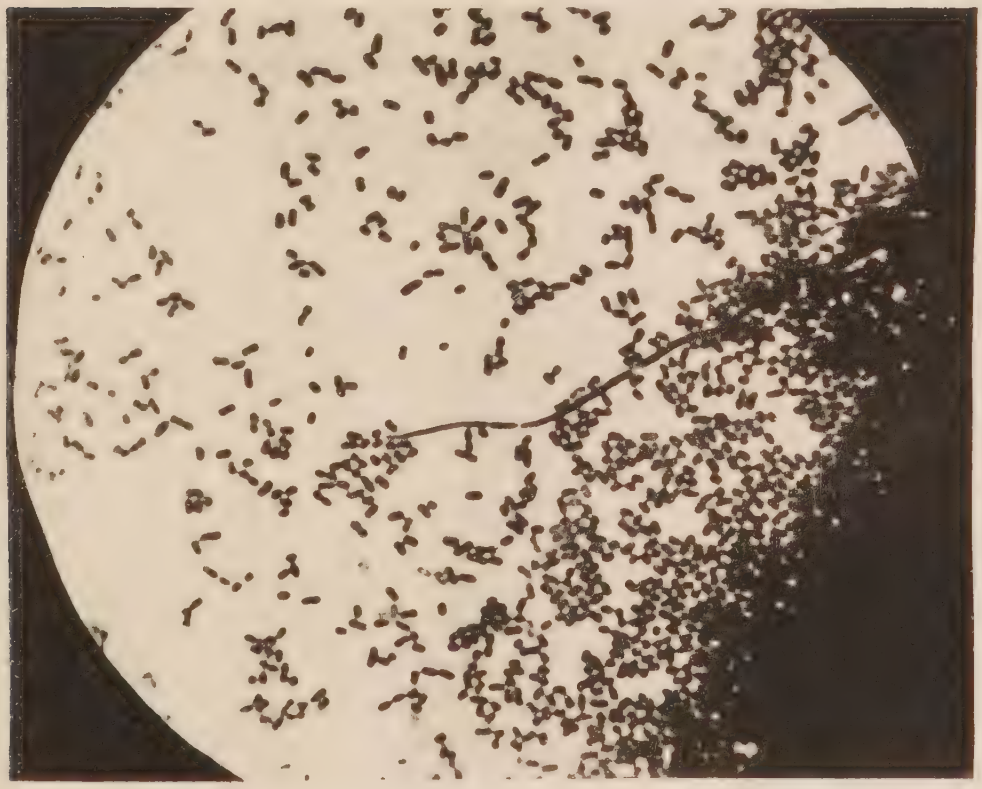


Fig. 4.

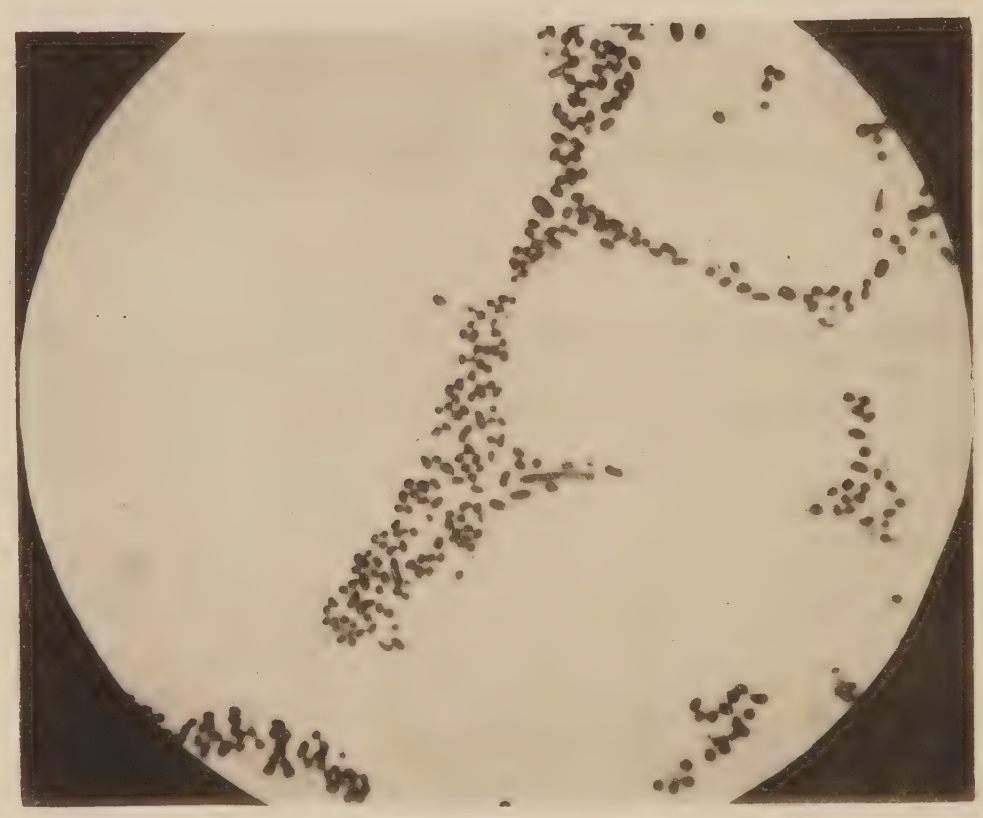


Fig. 5.

MIDDLESBROUGH PNEUMONIA.

FIG. 5.

Preparation from a pure subculture of *bacillus pneumoniæ* on gelatine several weeks old. Numbers of involution forms (swollen bacilli) are to be seen, and as well degenerated bacilli, some represented by mere empty sheaths.

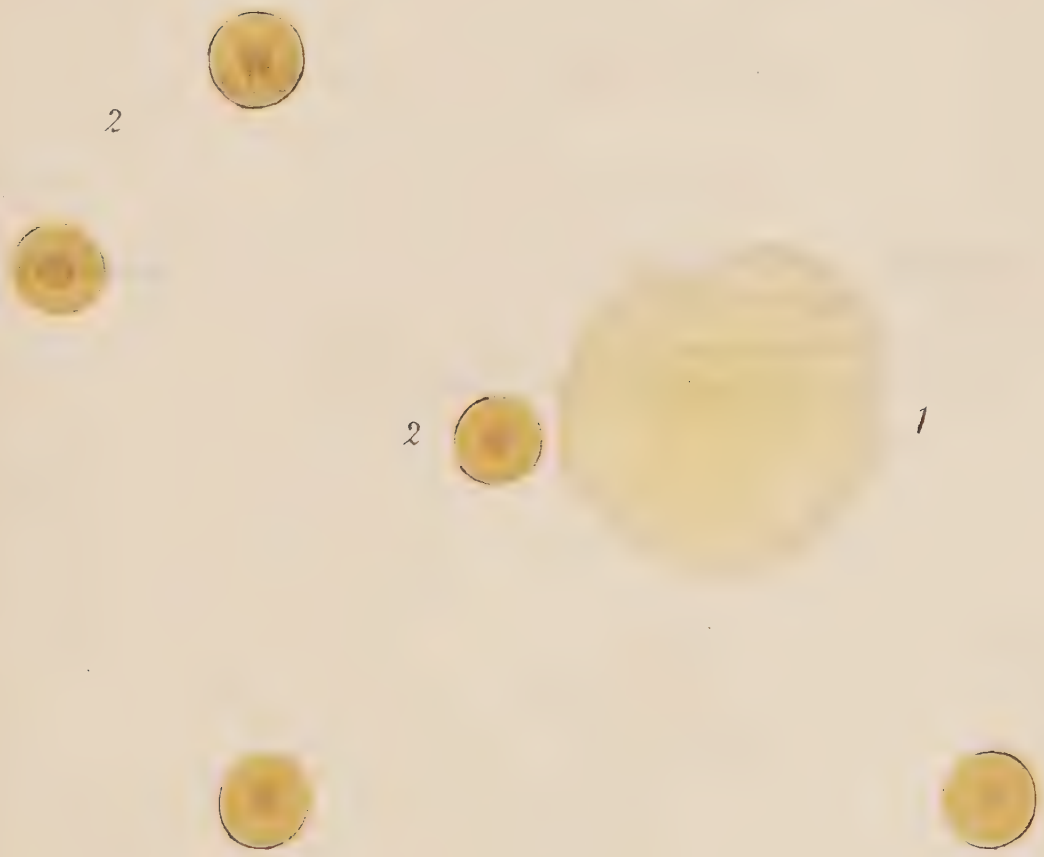
MIDDLESBROUGH PNEUMONIA.

Fig. 6.

Preparation from a gelatine-plate culture of *bacillus pneumonicæ* three weeks old. Magnified about 20 times.

1. Colony growing on the surface of the gelatine.
2. Colonies growing in the depth of the medium.

FIG 6.



H. Lapidge del. Dangerfield, Lithographer, London. 1675.



M.H.Lapidge. del. Fred^k Danbenfield, Lithographer, London. 17674

MIDDLESBROUGH PNEUMONIA.

Fig. 7.

Subcultures in test tubes of *bacillus pneumoniæ* on nutrient gelatine.

A. Subculture of material (juice) from human lung.

B. Subculture of blood from a mouse dead after inoculation with lung juice.

C. Subculture of heart's blood from a mouse dead after inoculation with the bacillus from a cultivation.

MIDDLESBROUGH PNEUMONIA.

FIG. 8.

Subcultures of a like sort with those of Fig. 7.

A. Subculture on surface,—from spleen of a mouse.
B. Subculture on surface,—from human lung.
C. Subculture in the depth of the gelatine,—"stab-culture."

Fig. 8. *To face p. 334.*



H. Lapidge. del. Fred^k Dangerfield, Lithographer, London. 17674.

No. 19.

REPORT on a prevalence of ENTERIC FEVER at MYTHOLMROYD, in the WEST RIDING OF YORKSHIRE, and on the GENERAL SANITARY CONDITION and ADMINISTRATION of the VILLAGE; by DR. PAGE.

THIS inquiry was ordered in consequence of frequent references to prevalence of enteric fever in this village, made in reports by the Medical Officers of Health of four several sanitary districts, and the impossibility of ascertaining from such disconnected and fragmentary information as was thus afforded an adequate account of its sanitary state and administration.

Topographical and general description.

The village of Mytholmroyd is situated about a mile to the east of the town of Hebden Bridge, in the valley of the Calder, at the confluence of that river and the Cragg or Elpha brook. Houses lie on both banks of the Calder, and upon the lower slopes of the hills flanking the valley at this somewhat narrowed part of its course. The arrangement of the dwellings in continuous rows and terraces gives the village a markedly urban character, the Burnley high road forming the principal street. Above the Burnley road, and also on the north bank of the Calder, the village is traversed by the Rochdale Canal. On the south bank, the Lancashire and Yorkshire Railway runs through the village. River alluvium occupies the valley flat, but elsewhere the surface is chiefly a sandy clay overlying the Millstone Grit. This formation is largely developed in this region, and crops out at the higher levels, where it is quarried for building purposes. The village ranges from 330 to 500 feet above ordnance datum.

Local cotton and woollen mills, and the various industries at Hebden Bridge, give employment to the inhabitants, and the general aspect of Mytholmroyd is that of a well-to-do and thriving community. The village is situated at the meeting point of four adjoining sanitary districts, into each of which it extends; namely, Todmorden Rural, and Hebden Bridge, Sowerby, and Midgley Urban, Sanitary Districts, and is comprised within the Ecclesiastical Parish of Mytholmroyd St. Michael. The Ecclesiastical Parish was formed in 1846, and had, in 1881, a population of 3,229 persons, inhabiting 761 houses. As to the population of the village proper, understanding by that term the community locally spoken of as Mytholmroyd, I found no data available for my purpose at the time of my inquiry, but the surveyors of the Todmorden, Hebden Bridge, and Midgley portions have since been good enough to make a special census, from which and from an estimate of the Sowerby portion it would appear that Mytholmroyd has a population of some 2,270, in upwards of 500 inhabited houses.

It would be difficult to explain, even by the aid of a map, the precise boundaries of each portion of the village which is comprised within the jurisdiction of these four Sanitary Authorities. By way of illustration

of their intricacy, however, I may mention that on the occasion of my interview with the chairman, clerk, and sanitary officers of Sowerby Urban District none present could at the moment inform me whether certain named localities were in that or the adjoining Todmorden quarter of the village. I must admit that it was not until I had obtained a bird's-eye view of Mytholmroyd from the parish church belfry that I was able to comprehend clearly its topography in relation to the several districts in question.

It may suffice to explain that that portion of the village which lies on the south side of the Calder is situated chiefly in Sowerby Urban District, a small part being in (Erringden township) Todmorden Rural District, and that the rest of its area on the north side of the river extends into Hebden Bridge and Midgley Urban and (Wadsworth township) Todmorden Rural Districts.*

Sickness and mortality.

In consequence of this partition of the village among four Sanitary Authorities, each exercising an independent jurisdiction and administering their respective areas without reference to the circumstance of the village as a whole, much difficulty has been experienced in learning anything respecting its sickness and mortality. The subject is undealt with in the statistics of the several sanitary districts and data are not readily available from which such information might be extracted. The reports of the four several Medical Officers of Health of the districts into which the village enters contain frequent reference to occurrences of enteric fever in Mytholmroyd, but it is to a private practitioner, Dr. Thompson, the only resident medical man there, that I am chiefly under obligation for what I have been enabled to learn regarding the extent of prevalence of this disease in the village and its immediate neighbourhood. Dr. Thompson informed me that cases of enteric fever have come under his notice every year during the past 11 years and that the disease is endemic in and about Mytholmroyd. During the winter of 1885–86 he observed over 50 cases of diarrhœa with typhoid symptoms and prostration, the patients being generally confined to bed from 7 to 14 days. Outbreaks of enteric fever have occurred in each of the four quarters of the village but with a chief incidence in the Sowerby and Midgley divisions. In his Annual Report for the year 1887 Dr. Lawson, Medical Officer of Health for Hebden Bridge Urban and Todmorden Rural Sanitary Districts, records three deaths from enteric fever in the Hebden Bridge, and one death from the same disease in the Todmorden divisions of Mytholmroyd village during

Enteric fever.

---

* Sanitary districts comprising within their respective areas portions of the village of Mytholmroyd :—

1. Hebden Bridge U.S.D. (Todmorden Union) :—			
Area in acres - - -	357		
Inhabited houses - - -	1,008	123	Mytholmroyd.
Population (1881) - -	5,007	526	
2. Todmorden R.S.D. (Todmorden Union) :—			
Area in acres - - -	19,800		
Inhabited houses - - -	1,666	131	”
Population (1881) - -	6,991	544	
3. Midgley U.S.D. (Halifax Union) :—			
Area in acres - - -	2,110		
Inhabited houses - - -	656	87	”
Population (1881) - -	2,939	350	
4. Sowerby U.S.D. (Halifax Union) :—			
Area in acres - - -	6,110		
Inhabited houses - - -	1,339	170	”
Population (1881) - -	6,179	850	

the year, and in connexion therewith makes casual allusion to a prevalence of the fever in the other portions of Mytholmroyd during a considerable part of the year. In the same year I find a report by the former Medical Officer of Health of Midgley Urban District of an outbreak of enteric fever during September in the Midgley Division of the village, embracing 19 cases, of which two proved fatal. No details of the outbreak are given. In October last the present Medical Officer of Health, Dr. Crowther, reported an occurrence of nine cases of enteric fever in the same division. I can find no reference in the reports concerning Sowerby Urban District to outbreaks of fever occurring in the Sowerby portion of the village.

In the following tables I have collected so much as I have been able to learn regarding the prevalence of enteric fever in Mytholmroyd during the past two years, distinguishing, by the aid of information kindly given me by Dr. Thompson and Drs. Crowther and Lawson, its incidence in each division of the village.

Enteric fever in families residing in Mytholmroyd and its immediate neighbourhood during 1887 and 1888.

Divisions of Mytholmroyd.	1887.			1888.		
	Families.	Cases.	Deaths.	Families.	Cases.	Deaths.
Hebden Bridge, population 526 -	8	10	3	4	7	2
Midgley, population 350 - -	14	34	4	11	17	2
Sowerby, population 850 - -	8	13	2	2	3	0
Todmorden, population 544 - -	6	9	1	2	2	1
Mytholmroyd, population 2,270 -	36	66	10	19	29	5

The next table shows the distribution month by month of household invasions by enteric fever during 1887 and 1888.

Month.	1887.				1888.			
	Hebden Bridge.	Midgley.	Sowerby.	Todmorden.	Hebden Bridge.	Midgley.	Sowerby.	Todmorden.
January - -		1				1		
February - -				1		4		
March - - -				2				
April - - -		1					1	
May - - -			1					
June - - -		1	3					
July - - -					2	1		
August - -	1	10	1	1	1	3		2
September - -	5				1	1		
October - -	1	1	2	1		1	1	
November - -								
December - -	1		1	1				
Totals - -	8	14	8	6	4	11	2	2

The third table shows the above collected cases grouped according to age and sex.

Age.	Males.	Females.	Total.
Under 5 - - - - - -	1	2	3
5 and under 15 - - - - -	15	13	28
15 and under 40 - - - - -	20	31	51
40 and upwards - - - - -	7	6	13
Totals - - -	43	52	95

From these tables it will be seen that going no further back than the past two years, an excessive amount of enteric fever sickness and mortality has prevailed in Mytholmroyd, fully justifying the account given as to the endemic character of the disease in that village. This endemic habit of enteric fever in the village as a whole would appear to have fastened itself also upon certain households. Thus of three families coming under my observation, in one, seven members had been successively attacked between January 1887 and February 1888; in another, five had been similarly attacked between April 1887 and August 1888, and in a third, a like succession of attacks occurred from August 1887 to October 1888. Other less striking instances of the kind in which two members of a family had been attacked at long intervals were met with. Local defects of a kind often found to be associated with the persistence of enterie fever, namely, defects causing excremental fouling of earth, air, or water, had, I learned, existed in the instances I have cited, and Dr. Lawson ascribes the recurrence of fever in certain houses coming under his observation to the absence of efficient disinfection of infected premises.*

The want of concerted action or communication between the several authorities had effectually stood in the way of that comprehensive inquiry into the origin and means of spread of infection which was indispensable, as well to the adoption of efficient preventive measures in each of their respective divisions as to the due sanitary administration of the village as a whole. Hence it is, perhaps, needless to remark that steps taken as to disease prevention in one part of it have been altogether without reference to, and altogether independent of, contemporaneous events in the remaining parts, although for anything that can now be affirmed to the contrary, a common cause of infection may have been in operation throughout the village.

The bearing of what I have said is seen in the circumstance that in August and September 1887, no fewer than 17 households in different parts of the village were attacked by enteric fever, the majority of which had no community of conditions accountable for the outbreaks saving the air breathed and the milk drunk. A consensus of opinion had been content to ascribe the fever to emanations from the sewage-polluted Calder, but the possible implication of the milk service as a more intimate factor in the case had escaped investigation prior to my inquiry, when unfortunately distance of time made further pursuit of the subject useless.

As a result of my inspection of the sanitary circumstances of the village, evidence was obtained of the prevalence there of unwholesome

* I am informed of the occurrence during February of this year (1889) of two cases of enteric fever in Midgley, one in Todmorden, and two (one fatal) in Sowerby divisions, all in localities previously infected.

conditions of water supply, drainage, and excrement disposal, such as enteric fever when endemic in a place is habitually associated with. And I also noted a distinct grouping of cases around different foci or centres of infection in several of the invaded localities, in close relation to one or more of such particular nuisances.

In the Midgley division, 20 yards of pipe drainage have been recently laid down replacing the upper part of a rubble sewer which was found to be blocked, by a telegraph pole erected some four years ago, causing saturation of the soil about the house doors with sewage matters. In this immediate vicinity, two households were attacked with enteric fever in August 1887 and again another household in February 1888. At Whitelea Terrace, a row of modern back-to-back houses, three households in a row of six were attacked between June and August 1887. The unventilated drain common to this row of houses discharges into a closed cesspool, the black stinking contents of which were oozing out at the time of my visit into the Rochdale Canal. Again, in two adjacent blocks of dwellings in Pall Mall, also in Midgley division of the village, five households were attacked between August 1887 and February of last year, out of some dozen in which the surveyor found the waste-pipes of inside sinks untrapped and in direct communication with the drains, and where at the date of my visit pail-closets provided with wooden boxes as receptacles for excrement were practically under the same roof as the dwelling and unavoidably from their position ventilating into it.

In Sowerby division, five houses have been attacked by enteric fever during the past two years, out of 22 dwellings situated in the "square" and draining into a stone highway sewer. I was informed that stone drains (since replaced by pipe drains) communicating with this sewer passed under the floors of three of the invaded households. In a dwelling-house situated near Calder Bridge, in another part of this division, wherein two cases of enteric fever had occurred in October and December of last year, the privy was placed in the corner of an outbuilding communicating with the house and projecting over the Cragg Brook. The water-supply of the household was obtained from a pump-well sunk upon the banks of the stream.

In Todmorden division, 3 houses out of 23 forming an isolated row, known as Club Houses, have been attacked with enteric fever, the source of water-supply, which had been condemned by the Medical Officer of Health, Dr. Lawson, being an open streamlet unprotected from pollution by cultivated fields and drainage.

The River Calder.

In connexion with these examples of fever prevalence in relation to various forms of excremental nuisance, the evidence implicating the River Calder as a source of infection may be considered here. There can be no question that this stream is highly polluted with sewage and excremental matters, and in its course through Mytholmroyd is aptly described as little better than an open sewer. By this time in addition to the drainage from groups of houses along its banks and higher up its course, it has already received the contents of the sewers of the towns of Hebden Bridge and Todmorden, the latter having a population of 24,000. The appearance of the river bed at Calder Bridge, too, justifies this description of it, and as well the universal complaints by inhabitants in Burnley Road and along its banks of the sickening exhalations which pervade the air, especially in summer when the natural volume of water is low and the decomposing sewage matters, liquid and solid, are more or less stagnant at this part of its course.* Medical opinion is equally unanimous in attributing much of the endemic fever of Mytholmroyd to effluvia thus arising, and which it is not unreasonable to infer may, on occasion, have a specific quality. Statistical evidence

* I leave out of consideration here the industrial pollution to which the inky discolouration of the river is chiefly due.

is not to be had in support of this doctrine, but the occurrences of the last two years, for 22 households out of 55 households attacked, are given below.

These 22 houses are situated in the immediate vicinity of the Calder, and on its north bank; 11 being in Hebden Bridge, and 11 in Midgley division of the village. The incidence of invasion in point of time has been as follows:—

1	household in	June 1887.
6	„	August 1887.
5	„	September 1887.
1	„	October 1887.
2	„	January 1888.
2	„	February 1888.
1	„	July 1888.
2	„	August 1888.
2	„	September 1888.

This evidence, I need hardly add, does not go far to implicate the river, especially in view of what I have already said as to the sanitary defects of the dwellings themselves.

Sanitary conditions. Water supply.

Small streams descending the hillsides are the chief local sources of water-supply. None of these can be said to be safe from contamination by washings from meadows and manured lands, and of some there is manifest exposure to gross pollution by excremental filth. This is notably the case of the chief local supply on the north side of the village in Hebden Bridge and Midgley divisions. The water is conveyed in pipes from a so-called spring on the hillside, issuing from beneath the meadow land of a farm at a higher level. At this farm a strong flow of water issuing from underneath the manure heap and receiving its drainage was, at the time of my visit, irrigating the meadows in question, upon the surface of which it ultimately disappeared. The farmer pointed out that occasionally the flow of water was diverted and turned through the farm buildings and a common privy for the purpose of washing out their contents upon the meadows, and he explained that by diverting it altogether from the field, the volume of water at the spring below became seriously diminished.

Another local source is a spout in a yard adjoining the White Lion Inn in Midgley division. Its gathering ground is in meadow land on the other side of the Rochdale Canal under which it is conveyed in a conduit of unknown material to the spout. It was formerly exposed to pollution from a midden privy said to have been placed on the line of pipe, and at the present time there is a midden privy within six feet of it. An analysis made in January last warrants the analyst in describing a particular sample of this water as "having the characteristics of a good "and pure drinking water."*

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* Halifax, Jan. 16, 1889.

Total solids in solution - - -	14 grs. per gallon.
Chlorine combined - - -	1·176.
(Calculated as common salt) - -	1·94.
Free ammonia - - - -	trace.
Albuminoid - - - - -	·03 per million.
Nitrates - - - - -	trace.

The water is clear and bright, emits no objectionable odour when warmed, and the residue obtained in evaporation does not char upon ignition. I am of opinion that the water has the characteristics of a good and pure drinking water.

(Signed) Wm. Ackroyd, F.I.C.,
Borough Analyst.

Besides such local sources, the mains of the Hebden Bridge waterworks extend into the village and supply 39 houses in Hebden Bridge, 35 houses in Todmorden, and eight in Sowerby division, but none in Midgley division.

Sewerage.

There is no system of sewerage in Mytholmroyd. Drains of various materials and construction including highway stone drains, receive house slops and empty at various points into the river, or in some cases into the Rochdale Canal. A short length of pipe drainage recently laid down in Sowerby division, and some 20 yards of pipe sewer replacing a defective length of stone drain as already described in Midgley division, represent the action of the authorities in providing their respective portions of the village with sewers. In houses of modern construction pipe drains and trapped sinks, commonly placed outside, have been provided. Untrapped stone or rubble drains exist in connexion with the older property. I noticed the soil-pipe of a house in the Sowerby division of the village discharging upon the banks of the Cragg brook.

House drainage.

Excrement disposal.

In Sowerby division uncovered midden privies are in vogue. Some of the largest were overflowing from long accumulation of their contents. A few recently erected houses are provided with pail closets. In Hebden Bridge division pail closets have entirely replaced the old midden privy, and in Todmorden division to the extent of one half the number. In Midgley midden privies prevail, but the middens are roofed over. As already stated a group of houses in Pall Mall have privies with wooden boxes in faulty relation to the dwellings. The Hebden Bridge Sanitary Authority have made arrangements for systematic scavenging and removal of refuse in their portion of the village, but in the remaining three-fourths of Mytholmroyd privy and ashpit cleansing is imposed on occupiers, and at the time of my inquiry matters were at a dead-lock in regard to the cleansing of the box privies of a block of property in Midgley portion, comprising 26 dwelling-houses, in consequence of difficulties in the way of getting them emptied. Several of the box privies were on the point of overflowing, and a serious state of things appeared to be imminent. An endeavour on the part of Hebden Bridge Local Board to bring about joint action in the scavenging of the village had failed. The Chairman and the Clerk of the Sowerby Local Board informed me on the occasion of our interview that great difficulty was experienced in securing the emptying of midden privies in their district, a statement which, to judge by the accumulations I encountered in that part of Mytholmroyd, I can very well endorse.

Slaughter-houses.

The slaughter-houses in Mytholmroyd, two in Sowerby, and one in Hebden Bridge divisions, are built hard against the river, into which their drainage and washings are directly carried.

Sanitary administration.

Todmorden Rural Sanitary Authority and Hebden Bridge Local Board have the services of the same Medical Officer of Health and of the same Inspector of Nuisances, while Midgley and Sowerby Local Boards have each their own officers. There are, as has been said, no less than four sanitary authorities concerned in the sanitary administration of this unfortunately circumstanced community, and with what aggregate amount of success must now be apparent to the reader of this report. A corresponding diversity prevails in regard to other matters. The three urban authorities of Hebden Bridge, Midgley, and Sowerby possess byelaws respecting new buildings, nuisance prevention, and the like, but none are in force in Todmorden Rural Sanitary District. Hebden Bridge and Sowerby portions of Mytholmroyd are lighted with gas, while the remaining portions are not.

Hospital provision.

None of the four authorities possess means of isolation or a disinfectant apparatus of their own. Sowerby and Midgley Urban and Todmorden Rural authorities have each entered into an arrangement with Halifax Town Council for the reception of patients in the Corporation Hospital, distant 6 miles from Mytholmroyd. Hebden Bridge Urban authority has a similar arrangement with Todmorden Urban authority for the use of their hospital, which is about the same distance from Mytholmroyd. During the past two years nine enteric fever patients have been removed from Midgley to Halifax Hospital.

None of the above sanitary authorities have yet framed regulations under the Dairies, Cowsheds, and Milkshops Order.

A community without proper sewerage, largely dependent for water upon supplies that are polluted, and for the most part left to shift for itself in the matter of cleansing of privies and ashpits, is unquestionably in a very rudimentary sanitary condition. Such is the case of Mytholmroyd. But I ought to state that the competence of the sanitary officers is not necessarily here called in question. Indeed, I would express my sense of the efficient advice in dealing with cases of infection and preventing the spread of disease given by Drs. Lawson and Crowther, the Medical Officers of Health of the Hebden Bridge and Midgley Districts respectively, as also of the zeal and ability of the Inspectors of these districts, Mr. Emmet Smith and Mr. Hodgkinson, who accompanied me during my inquiry, and to whom I am indebted for much particular information resulting from their own intimate acquaintance with the requirements of the village. The difficulties besetting the Authorities in dealing with the sanitary wants of Mytholmroyd are, in large measure, if not entirely, the result of divided (if not conflicting) responsibility, which has precluded that unity of action and comprehensive treatment which its circumstances urgently demand. It would be beyond the province of this report to formulate a scheme of amalgamation for the districts concerned, but it is quite clear that the vesting of the sanitary jurisdiction of the place in one responsible authority is indispensable to its substantial improvement and to the maintenance of its sanitary welfare. Another difficulty to be contended with is the pollution of the Calder. Remedy for this would seemingly depend at present upon the enforcement of the provisions of the Rivers Pollution Prevention Act by riparian authorities, who in this matter are themselves the offenders.

No. 20.

Report on Sanitary Administration in the Bridgend Registration District, Glamorganshire, with special reference to the Arrangements existing in the District for the Discharge of the Duties of Medical Officer of Health; by Mr. John Spear.

The registration district of Bridgend covers an area of 107,957 acres, or about one-fifth of the whole county of Glamorgan. Roughly speaking, it forms an irregular parallelogram, some 17 miles in length, from north to south, and 14 in breadth from east to west. It is situated at the south of the county; its northern boundaries abutting upon the registration district of Neath on the west, and that of Pontypridd on the east. On the south-east it is bounded by the registration district of Cardiff, and on the south and south-west by the Bristol Channel.

The northernmost third of this area stands upon the South Wales coal field. The surface is composed of the Penant sandstone rock, cut from north to south into deep and narrow valleys. Of these there are three principal ones, giving passage respectively to the Lyfni, Garw, and Ogwr streams. The two latter meet at Blackmill, some five miles above the town of Bridgend, and lower down the combined stream joins the Lyfni to form the river on which Bridgend stands. Immediately to the north of this town the millstone grit, a narrow belt of which surrounds the South Wales coal basin, crops out; and from this point southwards the district consists geologically of the lias formation chiefly, and of some tracts of mountain limestone.

The northernmost third of the district contains some six-tenths of the population, which, engaged almost exclusively in the coal and iron industries, is aggregated in small towns and villages situated chiefly along the narrow valleys. The main roads follow the line of the valleys; and in the three principal ones named above there are lines of railway. The roads are often in bad condition even for a rough mountainous district, and the railway communication is somewhat infrequent.

To the south the district is almost entirely agricultural, the inhabitants being collected in numerous villages and hamlets, some of them remote from railway communication. The country here is more level and the roads on the whole in better condition. The Great Western main line traverses the northern part of this division of the district from east to west, a junction for the valley railways and for a branch line to Porthcawl being at Bridgend. Bridgend and Cowbridge are the two market towns; Porthcawl a small seaside resort, and Southerndown and Llantwit coming to have pretensions in that direction. Of the market towns, Bridgend, from its situation near the debouchure of populous valleys, and from its railway communication, is by far the most important.

The population of the registration district, according to the census of 1881, was 38,920, and is now estimated at 44,130; or, excluding the inmates of the county lunatic asylum not belonging to the district, 43,230.* It is divided into three registration sub-districts: Maesteg,

* The arrangements given here are those that subsisted until May 1888; then a part of the parish of Llangynwyd higher (population 2,444), previously in the Maesteg Urban Sanitary District, was removed from the Neath registration district and added to the Maesteg sub-district of the Bridgend registration district, the said sub-district being at the same time divided. The effect is to increase the population of the registration district by the number named above, the population of the sanitary districts remaining the same.

estimated population 20,778; Cowbridge, population 7,045; and Bridgend, estimated population exclusive of strangers in the asylum, 15,407. Maesteg, the northern sub-district, is situated entirely upon the coal measures, and contains a mining population. It is here that over 80 per cent. of the estimated increase of population has taken place. In the Bridgend sub-district some 4,600 of the population, and in the Cowbridge sub-district about 1,000, are likewise located upon the coal measures, and are engaged in coal mining and iron and tin works. The mortality returns of the last few years are given in the annexed table. The general death-rate is high; that from "fever" conspicuously in excess of the average rate in the kingdom.

[In the table deaths in the workhouses have been distributed *pro rata* to each sub-district. The deaths amongst inmates of the county asylum have been excluded, save for a small proportion that, from the asylum reports of the last two years, may be estimated to have occurred amongst persons belonging to the district.]

Year.	District.	Births.	Deaths.	Deaths under 1.	Small-pox.	Measles.	Scarlatina.	Diphtheria.	Whooping Cough.	Fever.	Diarrhœa.
1883	Maesteg -	659	301	87	—	3	—	—	5	16	4
	Cowbridge -	171	118	27	—	—	8	—	1	4	—
	Bridgend -	503	330	82	—	3	3	—	—	26	5
	Total -	1,333	749	196	—	6	11	—	6	46	9
1884	Maesteg -	717	413	124	—	31	—	—	—	24	5
	Cowbridge -	217	126	25	—	—	1	1	—	4	—
	Bridgend -	492	320	84	—	38	1	—	2	10	14
	Total -	1,426	859	233	—	69	2	1	2	38	19
1885	Maesteg -	753	324	85	—	—	—	—	—	13	1
	Cowbridge -	202	145	33	—	6	—	1	—	1	1
	Bridgend -	549	255	58	—	3	1	1	2	8	4
	Total -	1,504	724	176	—	9	1	2	2	22	6
1886	Maesteg -	766	429	162	—	4	7	3	30	19	5
	Cowbridge -	194	147	29	—	7	2	—	11	1	—
	Bridgend -	492	279	56	—	—	—	4	9	5	6
	Total -	1,452	865	247	—	11	9	7	50	25	11
1887	Maesteg -	760	365	116	—	2	8	4	3	5	2
	Cowbridge -	178	104	24	—	—	—	1	—	2	1
	Bridgend -	466	343	84	—	—	5	3	7	14	9
	Total -	1,404	812	224	—	2	13	8	10	21	12
1888 (nine months).	Maesteg -	638	347	101	—	1	23	2	—	7	3
	Cowbridge -	145	91	16	1	—	1	1	—	—	1
	Bridgend -	381	232	42	—	4	3	—	—	2	4
	Total -	1,164	670	159	1	5	27	3	—	9	8
Annual average rates of 5¼ years.	Maesteg -	40·0	20·6	157	—	·4	·4	·1	·4	·8	·2
	Cowbridge -	27·4	18·1	140	—	·3	·3	·1	·3	·3	·1
	Bridgend -	33·0	20·1	141	—	·6	·15	·1	·2	·74	·5
	Reg. District	35·0	20·0	150	—	·4	·3	·1	·3	·70	·3
		Rate per 1,000 of estimated population.		Proportion to 1,000 births registered.	Rates per 1,000 of estimated population.						

Before September 1887 three sanitary districts only were comprised within this registration district: the rural district of Bridgend and Cowbridge, Bridgend urban, and Maesteg urban, the latter in the northern or carboniferous division. In September 1887 the Ogmore and Garw Local Government District, comprising the larger part of what remained in the rural district of the northern (carboniferous) area, was formed; and in November of the same year the little town of Cowbridge in the southern part of the district—an ancient borough which had hitherto remained for sanitary purposes under the jurisdiction of the rural authority—having received a Charter of Incorporation, became an urban sanitary district. I will consider separately the sanitary condition of each district as at present formed, although in dealing with administration I must necessarily refer to that of the authority from whose charge these newly-constituted urban areas have just been removed.

Bridgend and Cowbridge Rural Sanitary District.

The Rural Sanitary District comprises now an area of some 84,738 acres, or about 16 miles from east to west and 12 miles from north to south, exclusive of an elongated strip sparsely populated to the north. It overlaps the coal measures on the north, and nearly 8,000 of the total estimated population of 20,767 live in localities where coal mining and iron and tin works supply the staple industries. Porthcawl, Southerndown, and Llantwit are within this area; Bridgend and Cowbridge, geographically within it and with purely arbitrary boundaries, form isolated urban districts removed from the jurisdiction of the rural authority. The industrial, as distinguished from purely agricultural centres, extend into four of the five divisions into which the rural district has been formed for the purpose of the appointment of medical officers of health, and three of these divisions contain also one each of the small seaside resorts named above. Byelaws, based upon the Board's model, for the regulation of new streets and buildings, the removal of refuse, &c., were obtained in 1880 for the more populous parishes, including all those possessing railway communication, but excluding Llantwit and Southerndown. They are in operation in parts of each of the five medical officer of health districts.

Refuse Disposal.—Wherever in this district there is any collection of dwellings, sewage nuisances have been allowed to arise. Generally speaking the liquid refuse flows in dilapidated gutters or over bare surfaces to the nearest watercourse or to some stagnant pool; solid excreta accumulate for long periods in privy pits, often mere holes sunk in the vicinity of the dwellings, while ashes and house refuse are scattered indiscriminately over the surface of the ground. In only two places did I find that any serious attempt had been made to provide for the sewerage of a locality. At Porthcawl an owner of property had constructed a sewer for certain rows of houses, and, in conjunction with the authority, had provided a large porous cesspool for the discharge. The plan, which contemplates the soakage of sewage into the soil, is an infringement of all sanitary principles in the disposal of sewage, but nevertheless may be taken as indicating some appreciation of the necessity of provision for this object. At Llantwit, for the main street of the village, a 12-inch pipe sewer was laid down by the authority in 1887, the remainder and larger part of the village being still left to drain to stagnant, often dry, ditches, &c. The new sewer is ventilated by one 4-inch pipe only, and is imperfectly flushed. Such private connexions as exist were evidently made without proper supervision, and

in one case at least the overflow from a cesspool was allowed to be connected. Under these circumstances it is not to be wondered at that the work of the authority is complained of as a nuisance. For Aberkenfig, a mining village, and the most populous part of the rural district, the authority have for years had the question of sewerage under consideration; and it is alleged that the difficulty of obtaining land for outfall works has proved an insuperable bar to their action. Meanwhile the nuisances that have arisen here in consequence of inaction are extreme. In this village of Aberkenfig the only attempt in the district towards public scavenging has been made. An arrangement has been entered into with a neighbouring farmer to remove ashes, &c., deposited in certain fixed receptacles provided by the authority, and also to cleanse periodically the bed of a brook running through the village, into which much of the sewage finds its way. The equivalent offered for this service is the value of the manure removed; and the arrangement, owing probably to the smallness of the remuneration, has not answered, and the work is neglected. The emptying of cesspools, privies, &c., is everywhere left to owners or occupiers of houses. Cesspit privies of most objectionable type and construction are still erected under the direction of the authority, and where water-closets are provided, the discharge pipe is often left unventilated, and connected with an unventilated cesspool. It is only exceptionally (in the case of a few houses at Porthcawl) that flushing apparatus for water-closets is provided.

House Accommodation.—Much attention is required to the house accommodation generally of the district. In the older property of the poorer class, the floors, generally of stone, are often sunk below the level of the ground surface, while roof spouting is commonly wanting, so that the necessary result is excessive dampness. Several times in the course of my inspection I heard complaints of the ground-floor room being flooded during heavy rains, and this by water containing much surface filth, and occasionally I saw evidence of this condition. The better ventilation of sleeping rooms is a matter that likewise calls urgently for improvement. Houses are still being erected with small bedrooms unprovided either with fireplaces or special means of ventilation. Occasionally, although perhaps this condition is not general, bedrooms of this kind were found to be greatly overcrowded.

The Water Supplies of the district have engaged from time to time the attention of the authority. Early in 1887 a portion of Aberkenfig was supplied, the water being impounded on the hill side and conveyed by mains to the village. It was arranged at the time, according to the scheme submitted to the Local Government Board, that the owners of certain colliery houses in the upper part of the village should provide for their tenants from a similar source, but this has not yet been accomplished; nor have as yet all the houses in the lower part been provided, notwithstanding serious need, from the public mains. At Llanharan water was brought by pipes from springs on higher ground to standpipes in the village street some nine years ago by the authority. At Llantwit, also, water is conveyed to standpipes in the village from springs in the neighbourhood. The necessary works were completed, I am told, some years ago by a committee of the inhabitants, but have since been taken over and maintained by the authority. The supply is said to be at times insufficient. At Porthcawl the owner of a considerable portion of the village has recently provided for the distribution to his houses of water pumped from a deep well. For other parts of this village, and for many villages in the district, there are public wells or pumps, cleansed or repaired from time to time, as need be, by the

authority. In several parishes, however, the supplies are inadequate in dry seasons, and in several many of the inhabitants have at all times to go long distances for water. The quality, too, of the supply is, especially in the case of private wells, often open to grave suspicion; and occasionally people have to resort to streams polluted by sewage. I shall have to refer again to instances of all the conditions named above in dealing more directly with the question of sanitary administration.

Sanitary Administration.—The sanitary authority, as stated, have appointed five medical officers of health, being the poor law medical officers, with districts conterminous with the medical relief districts except that urban areas are of course excluded. The area and population of these several districts are given below, with the salary (partly repaid from the Parliamentary grant) which each officer receives. One inspector of nuisances only, Mr. Leyshon, is appointed for the district. He devotes his whole time to the duties of the office, and to those of the surveyorship, and receives a salary of 140*l.*, a moiety of which also is repaid, as inspector of nuisances, and 10*l.* per annum as surveyor.

District.	Officer of Health.	Area.	Population.	Salary.
				£
Brigend or Central -	Wyndham Randall -	25,359	4,699	30
Cowbridge - -	C. B. Meller - -	28,683	4,299	30
Northern (Maesteg) -	John Davies - -	5,141	1,927	5
Western - -	Philip James - -	17,101	8,341	30
Llanharan - -	David W. Davies -	8,454	1,139	10

The authority meet fortnightly, after the meeting of the guardians, and receive a report from the inspector of nuisances, who attends personally. The medical officers of health do not attend the meetings, and their advice is confined to written reports. The latter are made either at quarterly or at longer intervals; one officer (Dr. David Davies) appears to send in a yearly report only.

Although the districts bear in most respects a great similarity, as described above, there is no official communication or concerted action between the medical officers of health; nor, except on rare occasions, between them and the inspector of nuisances. The reports made to the authority by the medical officers, and the advice offered, are in essential respects in striking contrast and contradictory. Dr. Randall has repeatedly reported in the following sense: that "the privy accommodation of the district is most unsatisfactory;" "it is certain our death rate could be much diminished if the deficient privy accommodation were remedied and the removal of excreta improved, or if due care were taken to provide pure and wholesome water supplies for drinking purposes" (Annual Report, 1886); "these nuisances must continue to exist all over the district until your authority enforce those structural alterations in the privies which I have previously suggested [such as will prevent accumulation] or others adequate to meet the requirements of health" (Annual Report, 1887); and he enforces this advice from time to time by reference to certain individual nuisances. Dr. David Davies, of the Llanharan district, on the other hand, makes only an annual report, and finds in each that have been presented for the last three years, "nothing coming under his notice to which it is necessary to direct the attention of the Board." Dr. E. T. Davies, also, until

May 1888 medical officer of health for the Cowbridge district, reports for 1887 that although he had made "repeated inspections, nothing was "observed worthy of special mention to the Board;" and the newly-appointed officer, in the only general report he has yet made to the authority, while speaking of "pleuro-pneumonia and diphtheria as "epidemic in some parts of the district," concludes in a similarly optimistic way by referring to the "general sanitary condition of the "district as satisfactory." * Now these two districts, Llanharan and Cowbridge, are in no sense in better sanitary condition than the central district. One falls largely below it in total population, but, village for village, the aggregations of population are very similar; in the Cowbridge district, indeed, the aggregations are somewhat the more considerable. As a matter of fact, in both the Cowbridge and Llanharan districts, I found the grossest nuisances prevailing in consequence of the defective methods of excrement disposal; in both I found houses that from structural condition were unfit for human habitation; and in both I found, amongst other ill conditions connected with water supply, people resorting to streams polluted by crude sewage.

Dr. James, of the western district, has adopted a third course by advocating a change in the system of refuse disposal from a theoretical standpoint only. In his report for 1886 he says, "should the authority "feel indisposed to introduce drainage into Aberkenfig, I strongly "advise introduction of dry earth-closets; the condition there now is "very serious." Nevertheless, in the following year he reports, "I am "glad to say that the condition of closets at Jenkin's Row, Aberkenfig, "has been remedied by the building anew of twelve other closets "with large cesspool for each block of four closets."† And in another report, referring to an outbreak of scarlatina at Llalistone, he speaks with approval of a "large and commodious cesspool." In Aberkenfig a foul brook, receiving much solid and liquid refuse, traverses the village, and in the neighbouring town of Bridgend there is another one in every respect its counterpart except that it is arched over. Dr. James, reporting to the rural authority in 1887, suggests the cleansing out of the bed and the arching over of the waterway of the one at Aberkenfig. Dr. Randall, reporting about the same time to the urban authority upon the one at Bridgend, condemns in strong language the arching over of the brook there as hiding from sight a dangerous nuisance.

The northern division of the rural sanitary district was much curtailed by the formation of the Ogmore and Garw local board district in September 1887. Dr. John Davies, the medical officer of health, has in the main been content to offer general advice to the rural authority in the form of very short annual reports. So far as they go the recommendations offered have been sound, and might at least have led a careful authority to seek such further information as would have led to useful action. Perhaps because they came only at long intervals, and were lacking in specific and detailed application, they have met with little attention. I give below the salient points of his reports for the

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* The corresponding entry in the minute book of the authority is as follows: "Report read from Dr. Meller, from which it appears that the health of the district is satisfactory."

† I visited the property in question (Jenkin's Row). The lower tier of houses (they are built with a double-deck arrangement) stand against an earth bank, are excessively damp, and derive their sole air supply from doors and windows immediately facing the space across which the new privy cesspools have been erected. The old privies at the side remain, and the new ones constitute a dangerous aggravation of conditions that already rendered the houses quite unfit for human habitation.

last few years :—*1885:* "High mortality from diseases of lungs, partly "produced by damp houses, badly drained buildings, wet streets, and "accumulations of sewage matter on house premises. . . I have "regularly called your attention to these matters for the last six years." Typhoid fever epidemic at Pontycymmer (at that time in the rural district). "Primary cause, sewage matter on premises and possibly use "of polluted water." *1886:* "Mortality statistics prove that the sani-"tary state of the northern district is not satisfactory; this is specially "the case at Pontycymmer, where deaths from preventable disease have "been so numerous. The cause traceable to vitiation of air from "decomposing sewage matter and possibly from imperfect house "drains." *1887:* Another outbreak of typhoid fever at Pontycymmer. "The fever is fairly attributable to very defective house drains and to "the want of a system of sewerage."

The reports of the medical officers of health are not, it is to be remembered, supported by the presence of the officers at the meetings of the authority. Considered as a whole (from the several districts) they are inconsistent, and in fact, flatly contradictory of each other. With few exceptions the best of them are wanting in reference to individual cases in which the authority's intervention is needed. Under the circumstances it is not to be wondered at that the authority has turned for advice to the officer who at least has official connexion with the whole district, and who is at hand to give advice. This is Mr. Leyshon, the inspector of nuisances, an old and respected inhabitant of the district, once a prosperous farmer and vice chairman of the board of guardians. The nature of his advice is shown in the following passage (one of several of the kind) in a report of July 11, 1888.—"There are "a few privies at Bryncoch" [reported by the medical officer of health to be a nuisance and associated with the appearance of typhoid fever] "rudely constructed, but I do not consider it to be a nuisance. They "are kept, as a rule, fairly clean, and when otherwise, on my calling "the attention of the tenants to them, they are cleansed. The same "will apply to all the privies in my district;" and the result of his advice in the following resolution of August 4, 1888.—"The authority, "while regretting they are unable to agree with the medical officer of "health, are decidedly of opinion that if the old privies are properly "looked after they are sufficient for the requirements of health." In short, the outcome of this system of administration is the deliberate setting aside, in matters that vitally concern the health of the district, of the recommendations of the responsible officer; and of the only one in the service of the authority who has shown at the same time soundness and sufficient insistence to command attention, in the performance of the responsible duty of advising on matters affecting the health of his district.

This result, expressed in formal phrase in the above resolution, is no less apparent in the actual working of the sanitary machine. The very important powers conferred upon the authority by the Public Health (Water) Act of 1878, of preventing the occupation of houses newly built without a certificate of sufficient and wholesome water supply, are administered without reference to the medical officers of health, who are never consulted in the matter, and offer no opinion. The certificate is granted solely on the representation of the inspector of nuisances, and although that officer has evidently endeavoured conscientiously to discharge the duty entrusted to him, mistakes have been made that with further forethought and experience might have been avoided, and certificates have been granted when they ought properly to have been withheld. In the same way any attempted improvement in the public

supplies of the various villages is made without reference to the medical officers. It was decided lately, for example, to sink a well at St. Brides Major for the supply of the village, and although from the geological formation (a fissured limestone) special precaution was necessary in the selection of a site, the medical officer was not consulted. That officer tells me that the site actually chosen (by the inspector of nuisanoes and the guardian of the parish) appears to him on cursory examination to be too near the churchyard, but that the work of sinking the well was proceeding before he was cognizant of the intention of the authority. In his report for 1887, Dr. Randall, referring to an outbreak of typhoid fever at Bryncoch, stated that, in addition to other unwholesome conditions there, the water supply was liable to pollution; that it was deficient in quantity, and at too great a distance from the houses; and this information was repeated in the first two quarterly reports of 1888. The matter was referred, according to custom, to the inspector of nuisances, and following his advice a little masonry was inserted across the face of the spring at the dipping point. I visited this place and found a slowly-trickling spring of water in the side of a gully, situated some 400 yards from the houses across a rough, and boggy, and exposed heath. The medical officer of health was no doubt justified in thinking that at small expense the supply might be augmented and carried in pipes by gravitation to the hamlet. The inspector of nuisances had, however, reported "I consider Bryncoch now well supplied with water," and the authority were no doubt satisfied.

Building operations have been going on to a considerable extent of late years at Porthcawl, in the western district, and in a small way elsewhere. Nevertheless, the medical officers of health are never consulted respecting the administration of the building byelaws, nor, except for a few general remarks in one of Dr. James's reports as to the advisability of the ventilation and dis-connexion of house-drains, do I find that any attempt has been made on their part to fulfil this important junction of their office. Accordingly, the most important byelaws from a sanitary point of view—as to construction of drains, cesspools, privies, foundations of houses, the ventilation of bedrooms, &c.—are habitually ignored.

Under the Dairies, Cowsheds, and Milkshops Order, premises are registered upon the advice of the inspector of nuisances alone. I have not found in any case that improvements in the construction, furnishing, or management of dairies, &c., have been secured, although often much needed. The medical officers of health are never consulted on the subject, nor have they made any representation to the authority as to the important uses to which the order might be put in protecting the public health. At present the mere registration of dairies serves no intelligible purpose.

The effect of this system of sanitary management is to obliterate the most important function—that of an adviser of the sanitary authority—of the medical officer of health; and this in its turn disorganises the whole sanitary machinery. The inspector of nuisances, acting without the co-operation of the medical officers of health, is deprived of the moral support to be derived from medical authority, and is unable, at least within any reasonable time, to carry out even such improvements as he deems necessary should they infringe private interests. I will give one or two instances, among such a number as to indicate that the difficulty is constant, to show how ineffectual have been his efforts.

On the 24th June 1886 Mr. Leyshon reported that there was insufficient privy accommodation at Verity's Court, Cowbridge, and notice to provide

it was served on 5th July; on September 23rd the notice was reported not complied with. On April 26th, 1887, small-pox broke out in Verity's Court, and the inspector then reported: "Mr. Rees has deceived me by "promises until the notice given him is powerless; will the authority "please direct me to give him a fresh notice." Fresh notice was served on May 9th, but it had not been complied with when Cowbridge was made an urban district on November 1st, nor has the work been done, I believe, up to the present time. [I visited Verity's Court, and found that deficient closet accommodation was by no means the worst of the evils existing there. The houses have no through ventilation, and within 3 feet of the door of one of them was an enormous midden containing five or six cart-loads of refuse (two loads had been removed some three weeks before, and this accumulation left), and foul liquid from the midden was oozing on to the surface of the dilapidated yard—the space from which the houses derive their air supply. In one bedroom of 840 feet cubic capacity, that is to say, giving space for three inmates at the most, six persons were sleeping. The medical officer of health informed me that a case of typhoid fever had occurred in this court since the small-pox outbreak.]

In his reports for 1885 and 1886, Dr. Randall had referred to the defective privy accommodation at the village of Wick (at the school-house amongst others), urging the authority to secure the adoption of pail closets, or "at least small impermeable pits," and in a quarterly report of 1887 he specially referred to the Star Inn, where liquid from the privy "soaked under the floor of the house," and advised the substitution of a pail closet. On the 10th November the inspector of nuisances reported upon the case. "I find no nuisance in or about the privy," he said, but he admitted that it would be better removed from against the wall of the house, and accordingly a notice "to provide proper privy accommodation" was issued on November 21st. On January 5th, March 13th, and May 30th it was reported that the notice had not been complied with; on July 13th the new privy had not been completed; on August 1st it was reported finished. As to the others reported by the medical officer of health to require structural alterations, the inspector of nuisances reported (August 1st, 1888), "There are a few rudely con-"structed privies at Wick, but I am not prepared to say that they are a "nuisance." [I visited this village in the course of my inspection. The new privy at the Star Inn was a few yards further removed from the house, but was of precisely the same character as the last, with deep porous and unventilated cesspool. The closet accommodation in the village generally, including the school-house, was of a similar kind, allowing much accumulation and soakage of fœcal matter about the houses, and constituting a serious danger to the inhabitants. Several of the houses also, from dilapidation and dampness, are, in their present condition, unfit for habitation.]

On October 28th, 1886, Mr. Leyshon reported "There are 11 houses "belonging to the Rev. Mr. Morse at Bryncoch with only five privies, "and also a very foul and stagnant gutter at the back of the premises;" and on the 8th November 1886, a notice was served to abate these nuisances. On 18th January 1887, notice reported not complied with; February 7th, reminder sent; May 4th, "notice not complied with." On October 21, the inspector finds "nothing fresh at this place calling for special notice"; on December 7th he finds the privies "require cleansing." Later in the month typhoid fever is reported by Dr. Randall to have broken out in Mr. Morse's houses, and on January 8th, 1888, the privies were "cleansed." On the 5th May, Dr. Randall, referring again to the outbreak of typhoid fever, spoke of the privies at Mr. Morse's houses as "most unsatisfactory." It then appeared that the notice served in October 1886, as to the privies and drains, had never been complied with, the inspector excusing himself on the ground that some of the houses had been unoccupied. On the 21st May 1888, a second and similar notice was served. On July 31st, Mr. Morse was reported to have completed the drains, but not the privies; on September 4th he had "completed the new privies and also the drainage." [It was essential that I should see the results of all this labour, extending over nearly two years,

and I accordingly visited the premises. I found the 11 houses built in two rows at right angles to each other, their backs facing upon the common yard—a triangular piece of wholly unpaved ground. Until the recent alterations all liquid sewage had flowed across this unpaved space in an open gutter; now a pipe had been laid with three gully openings. The latter, however, were so badly constructed that much of the sewage still spread itself over the unpaved surface. The surface was still filthy and sewage sodden, and one tenant complained that the liquid filth flowed into his kitchen. Moreover, the drain terminated within three feet of the lowermost house, and there the sewage created, in a dilapidated gutter, a foul nuisance. Within the triangular space, about 23 feet from the houses, the original privy cesspits stand in two separate blocks, and now a third block was built, the cesspit of which came within about 18 feet of the houses. The original cesspools are about 8 or 10 feet long, and 6 feet deep, the new one about 15 feet long and 3 feet deep. The latter is constructed of rough stonework and is not ventilated. It constitutes undoubtedly a fresh source of danger to the locality, while the pipe drain provides no remedy for the nuisance it was designed to remove.]

In dealing with infectious disease the authority have been content to supply gratuitously carbolic acid, &c., when applied for, to be used according to the directions of the medical officers. No public provision for the isolation of infectious cases has been made, nor have any organised means been devised for the early discovery of such cases. Dr. Randall reports in April 1888 "a considerable epidemic of scarla-"tina at St. Brides Major, due to non-isolation of cases as they arose;" Dr. James, in a report of December 1887, mentions the discovery of an outbreak of scarlatina in two families at Llalistone "six or seven weeks after its occurrence," and of a fatal case of typhoid in the same village some months after the death occurred.

The study of sanitary methods in this rural district shows that to real progress the cessation of divided counsels from officials is absolutely essential, and that the attempt to obtain a workable solidarity and consistency in administration with the aid of several responsible advisers, in one department, has proved, from inherent weakness of the plan, a lamentable failure. What is required is a well-informed medical officer of health, devoting a considerable portion of his time to sanitation in the district, possessed of some organising capacity, and capable of acquiring the confidence of the sanitary authority. The special and most important functions of such an officer have now, in this rural district, come to be imposed upon one not intended by the sanitary law to exercise such functions, not armed with the necessary moral authority, and not possessed of the requisite knowledge and training.

No question of course arises in dealing with a limited area of this sort as to the adequacy of one medical officer of health to exercise sufficient supervision; but it may be asked whether, as a matter of convenience and of facility of supervision, there is not some advantage in having the services of five officers rather than of one. Even if the duty of visiting and inspecting localities be alone thought of, the answer to the question would seem to be that there is no such advantage. The district under notice may be considered roughly as a circular area with the town of Bridgend at the centre. One of the present medical officers of health resides in this town; two others at the circumference of the circle, and the two remaining ones beyond the circumference, two or three miles beyond any populous part. As a mere matter of economy of distance to be travelled it would seem that one officer living in the central town is in at least as favourable a position as the five combined: in whichever direction he leaves his town or by whatever

road he returns, he would habitually be within the area of his duties. On this point there is indeed no room for doubt when the overlapping of the existing districts comes to be considered. Taking only the populous villages, we find the following results: the medical officer of health of the central district, in visiting Wick, is within three miles of Llantwit (the most populous place in the Cowbridge district), distant four miles from Cowbridge, the residence of the present medical officer; in visiting Pencoed he is within three miles of Llanharan (the most populous place in the Llantrisant district), to which the present medical officer has to drive some four miles from his residence; in visiting Bryncoch and Bryncethin he passes within a mile of Aberkenfig (the most important place in the rural district), or, when at home, he is within three miles of that place (either by road or rail), while the present officer lives some seven miles away; in visiting Bryncethin he is within a mile of the most considerable part (Ynisawdre) of the western division, or when at home within about three miles, while the present officer's residence is some five miles distant.

It may be said that the several medical officers of health are the poor law medical officers for their respective districts, and that in their frequent visits in the latter capacity they conveniently perform the duties of the other office. There is, however, abundant evidence before the Board that these duties cannot be properly discharged in that incidental and subsidiary way. Nothing is more common than to find that inspections so undertaken have proved a positive disadvantage and snare, leading a medical officer of health to suppose that he has discovered all the circumstances of a locality when he knows only a fractional part of them. Careful, systematic, detailed, house-to-house inspection, at frequently recurring intervals, of an area whose boundaries and co-relations are well understood, is what is needed; and it is only upon information so obtained that competent advice for a sanitary authority's guidance can be looked for.

Still, it may be said, the fact that such divisions have been made for poor law purposes affords presumptive evidence that they are convenient ones for supervision; and no doubt this argument goes for much with a sanitary authority that is also a board of guardians. In this particular case, the conditions have been entirely altered by the removal of various areas that have been constituted urban districts, so that the poor law divisions and the sanitary divisions are no longer conterminous. It may, for example, be necessary that a poor law medical officer should live at Maesteg and another at Cowbridge, but neither of these places are now under the jurisdiction of the rural authority. But, apart from this consideration, the argument stated above loses its apparent weight when the necessities of the two offices are taken into account. Urgent calls may be an almost everyday occurrence to the poor law medical officer, but are a rare necessity to the officer of health; in the one case the convenience of the public in applying for aid or seeking medical advice has to be considered; in the other, the nature of the duties does not require visits from the inhabitants.

In the above remarks the question of superior convenience has been considered from the point of view of the neeessities of local visits and inspections alone. In relation to other duties—the necessary attendance at the meetings of the sanitary authority in affording personal assistance and advice, the necessary co-operation with the iuspector of nuisances, &c.—the advantages of one appointment, as compared with several, are too obvious to need further comment.

There are still other reasons for preferring one appointment in this district. Questions are arising as to sewerage and water supply of

various localities that will require from the medical officer of health, if his advice to the authority on such matters is to be of value, or his subsequent supervision effective, a far more comprehensive view of the sanitary condition and necessities of the district than any knowledge, however intimate, of any one locality can give him. To this matter I shall have again to refer after dealing with the sanitary condition of the adjacent urban districts.

Bridgend Urban Sanitary District.

The Bridgend urban district stands upon a limited area of 630 acres, and contains a population estimated at 4,200. From its situation some three to four miles below the juncture of populous mining valleys, it is an important market town ; and possesses railway communication with the north and west and east, and converging high-roads on all sides. The streams from the north have united some three miles above to form the combined Ogwr river, and it is upon either side of this, a broad and rapid, though shallow river in time of flood, and in dry seasons a mere streamlet occupying but a fractional part of the stony bed, that the town is built. Geologically the lower part of the town stands upon alluvium, the higher parts upon the lias formation.

Sanitary Condition.—The great want in this district is a proper system of sewerage and drainage. Short of providing this, the sanitary authority have not on the whole been inactive, but the great omission overshadows such improvements in scavenging, paving, &c., as have been introduced, and renders them to a large extent nugatory. The most important of the main sewers are constructed of rough masonry, and could only be properly used for the conveyance of storm water; one at least consists of the natural rough bed of a more or less stagnant stream that has simply been arched over. Into these channels, upon which the sanitary authority annually spend 30*l.* in attempting "disinfection," most of the pipe sewers that have been constructed discharge. These latter are very imperfectly ventilated, and one, intended to serve the populous locality of Old Castle, is laid so shallow that several small branch streets cannot be connected. The private drainage of the town is generally much in need of attention. Drains, I am told, are often found constructed of brick or stone and leaky. They are generally unventilated, and water-closets are not provided with water for flushing purposes. For the branch streets at Old Castle referred to above (South Street, St. Mary Street, part of Chapel Street, and Madox Place), as well as for a considerable collection of houses at Green Street and New Town, to which no sewers have been extended, cesspools have to be depended upon. It can only be a very small palliative measure to provide, as the authority have done, for the frequent removal of ashes and house refuse, when the more obnoxious sewage in in so many places stored for prolonged periods in leaky cesspools and privy pits in the immediate vicinity of dwellings; or, at best, discharged into drains and sewers of the character described.

Moreover, the receptacle for the sewage discharged is the bed of the Ogwr river; and two of the public culverts and several private drains empty themselves within a few yards of the point where the river enters the town. In wet seasons, when the river is full, no complaint arises, and the sewage is carried to the sea some four miles below without being further heard of; but in summer, when the sewage has often to trickle over bare stones, or forms here and there stagnant pools, the nuisance from this cause is said to be most serious.

A large proportion of the house property of Bridgend is old and of an inferior kind. Many of the cottages are excessively small and confined, ill-ventilated, damp, and dirty. In certain cases attempts to improve the ventilation have been made under the authority's order, and some two years ago one row of houses was closed as unfit for habitation. There are others at Old Castle, and a row of six on New Castle Hill, that require now to be similarly dealt with. In these small, ill-ventilated cottages, overcrowding is occasionally observed.

Building byelaws, based upon the Board's model, were obtained in 1883, and in the small amount of building that is going on attention is apparently paid to their due enforcement. I found, however, one new house occupied by a family, including several children, before completion, and long before it could be considered in any proper sense habitable.

The authority have made considerable improvement of late in the paving of several of the public streets. Many of the smaller private streets, however, and a large proportion of the house yards, are in this respect greatly neglected.

The water supply of some nine-tenths of the town is in the hands of a private company. Water is obtained at present from springs in the lias limestone about three miles to the south, that is below Bridgend, at a point where discontinuance of pumping is occasionally necessitated by the invasion of high spring tides. The water is stated to afford satisfactory results on analysis, and is distributed on the constant service principle.

The company have likewise powers of distribution over some parts of the rural sanitary district, including St. Bride's and Southerndown, and have, I understand, offered to supply the latter place, where water is much required. It is believed that a new source of supply will be obtained eventually from the northern water-sheds, in which case other parts of the rural district, where water is now much needed, would come more practically within the range of the company's service.

In addition to the company's mains, there is in Bridgend, at the foot of Station Street, a public fountain, supplied through pipes with water from an adjacent hill, to which a number of the inhabitants on this side of the town resort; and again there are a certain number of houses, beyond convenient reach of the public fountain, practically unprovided. This is the case with a row of twelve in North Street, the inhabitants of which, notwithstanding that the authority commenced action some two years ago against the owners on this account, are still left to obtain water from a polluted stream.

The provision made in the district for dealing with infectious diseases is altogether inadequate. No hospital is provided, while attempts to isolate sufferers in their own homes are, in the small cottages of the district, necessary futile. Neither is there any disinfecting apparatus. The action of the authority in this important respect is confined to the gratuitous distribution, in cases that happen to come under their notice, of disinfectants, which are used under the direction of the medical officer of health, assisted by the inspector of nuisances.

Administration.—The medical officer of health, Dr. Randall (medical officer of health of the central division of the rural sanitary district), was appointed in 1885, and receives a salary of 25*l.* per annum, part of which is repaid out of the Parliamentary grant. His present term of office expires on March 25th, 1889. He presents quarterly and annual reports, but does not attend the meetings of the authority. The inspector of nuisances is in frequent communication with him, and in cases

requiring it acts under his directions. In the reports of the health officer most of the points to which I have referred have been brought under the notice of the authority; and such improvements as have been carried out of late appear to have been instituted for the most part on his recommendation. The officer has found reason to attribute the periodical appearance of typhoid fever in the district to the defective sewerage of the town, and this subject has been repeatedly brought by him under the notice of the authority. In respect of this most important matter, the authority have had before them various schemes—one contemplating the carriage of the sewage by properly-constructed culverts to the sea; another, its application to land at an intermediate spot—but neither the one nor the other has ever been taken into serious consideration. The attitude of the authority is in fact expressed in a resolution, passed in (1882 ?), and re-affirmed in July 1886, in answer to an inquiry from the Board, to the effect that as all sewage from the Lyfni and Ogmore Valleys passes into the river above Bridgend, they feel indisposed to spend a large sum on their own sewage disposal. Meanwhile, not only does the river receive fresh and large pollution from Bridgend, but a considerable proportion of the sewage is retained within the town limits, in improperly constructed sewers and cesspools and by leakage into the soil, to the serious endangerment, as the medical officer of health points out, of the health of the inhabitants.

In the Lyfni and Ogmore Valleys there are, in addition to Aberkenfig, the most populous place in the rural sanitary district already described, two local board districts, those of Maesteg and Ogmore and Garw, and to these I will now direct attention.

Maesteg Urban Sanitary District.

Maesteg is situated towards the upper end of the Lyfni Valley, some nine miles above Bridgend and six above Aberkenfig. The town is built on either side of the Lyfni (a mere brook often in summer, and in time of heavy rainfall a rapid river), the lower parts standing on alluvial deposit, the upper on the broken Penant sandstone and detritus of the neighbouring hills. The area of the district is 6,813 acres, and the population, at the census of 1881, 8,310, is now estimated at 9,000.

The population is almost exclusively an industrial one, coal mining, iron, and tin-plate working affording employment. Owing to the closure or partial closure of large works, failing prosperity has afflicted the district since 1883, so that the rateable value has decreased, I am told, by some thousands. There is now, however, owing to the intended establishment of new works, promise of immediate improvement.

The district bears obvious traces of impoverishment. The roads are neglected, the by-streets unmade, and a large proportion of the houses in a state of disrepair. There are indeed many in the district so damp, dilapidated, ill-ventilated, and otherwise ill-provided (in matters of drainage and sometimes of water supply) as to demand the attention of the authority with a view to their closure. The Lyfni and Tondû Coal and Iron Company, the great employers of labour in the district, are the owners of some such houses; and since the pinch of falling prices was felt, they have in several cases required their workpeople as a condition of employment to occupy the houses in their possession. The requirement is inimical to the health and comfort of the men and their families, and in several instances has led to the vacation of more decent dwellings for others unfit for habitation.

The sewage of the town and neighbourhood finds its way eventually to the river, or rather, in seasons when the water is low, to the bed and banks of the river only, and in the latter case until the next heavy fall of rain, which, fortunately for the district, is not often long delayed, there is the growth of a most offensive nuisance. The channels of communication are various—by open rivulets, by brick and stone highway drains, and by a number of pipe sewers that have been laid by the authority. Into several of these channels a flush of water from some hill-side rivulet has been diverted, but when most required this means of flushing is apt to fail. Ventilation of sewers is very imperfectly provided for.

The sewers and other channels spoken of receive as a rule sewage in a form the most offensive and most difficult of removal, that is to say when far advanced in decomposition, from the overflows of cesspits, &c. Closets consisting merely of roughly bricked holes, with an overflow to the nearest sewage channel, still exist in large numbers; and although the authority have taken steps to replace many of these by "syphon closets," with drain connexion, the change under present circumstances cannot be regarded as an altogether judicious one. The water supply in the district is scanty, and the syphon closets have as a rule become a nuisance through defective flushing. Pail closets have been introduced in one part of the district, but the work of emptying and removal of the contents is left, with the usual unsatisfactory results, to the tenants.

The removal of ashes and house refuse from the neighbourhood of dwellings is undertaken by the authority, and is effected at frequent intervals. The refuse is, however, occasionally deposited improperly on the banks of the Lyfni.

The water supply of the district is undertaken by the authority. Water is collected from hill-side springs in a small storage reservoir, and thence conveyed to standpipes, of which there are some forty in the town and district. At its source the supply, having regard to the storage capacity, is limited; and as distribution within the town is carried on, even in important places, partly by glazed socketed pipes in which pressure is often almost nil, the flow at many of the standpipes is slow and inadequate. Moreover, an increase in the number of standpipes is greatly needed, and this cannot, owing to insufficient supply and inadequate pressure, at present be obtained. Further, the use of fragile earthernware pipes, in a general water service within a populous locality, should be regarded as inadmissible from the point of view of protection of the water against befoulment. The authority have had the question of the improvement of the supply under consideration at different times, but beyond an arrangement with a neighbouring landowner for the acquisition of certain springs if their use be finally decided upon, no progress has been made.

The authority have made no permanent provision for dealing with epidemic and infectious disease. In 1886 two cottages on the hill-side were acquired with the intention of using them as a place of isolation in case of need, but beyond this the plan was not proceeded with. The cottages have not been properly prepared for such a purpose. The authority possess no disinfecting apparatus. Chemical disinfectants are supplied gratuitously to infected households, and used, in cases that come to his knowledge, under the directions of the medical officer of health or inspector of nuisances.

Administration.—The medical officer of health, Dr. W. H. Thomas, is appointed annually (from each Lady Day) at a salary of 20*l.*, one-half of which is repaid out of the Parliamentary grant; the surveyor

and inspector of nuisances receives, as surveyor 30*l.*, and as inspector 60*l.* per annum. The medical officer of health presents quarterly and yearly reports, but does not attend the meetings of the authority; and, perhaps in consequence of this, little evidence can be found of his influence upon the authority's administration. He has, in his reports, from time to time drawn attention to the insufficiency of the water supply; and in reporting the appearance of enteric fever and other infectious diseases he states that all precautions as regards disinfection, &c., have been carried out, and nuisances associated with the infected dwellings removed. In a supplementary report to the authority in 1884 (made at the request of the Board) he thus expresses himself—"I visit the whole of the district two or three times a week, and as a "rule my suggestions to householders are acted upon, thereby "rendering it unnecessary to report to you matters that may be "remedied without so doing." No doubt in this unostentatious way Dr. Thomas's influence has been very beneficial; but such efforts alone, on the part of the health officer of a district where many extensive improvements and much activity on the part of the authority are needed, cannot be considered satisfactory. No doubt the officer's duty as an adviser of the sanitary authority is rendered more difficult by the circumstance that the Lyfni and Tondû Coal and Iron Company—the company to which many of the worst, if not the very worst, houses in the district belong, and that compels, in the way described above, the occupation of these houses—can command a majority on the local board. The fact however remains that no official representation has been made by the medical officer of health as to the houses in the district unfit for habitation.

Ogmore and Garw Urban Sanitary District.

This district was formed in September 1887, being prior to that date part of the rural sanitary district. It lies to the north of Bridgend, ann east of Maesteg; covers an area of 17,926 acres, and has a populatiod now estimated at 11,434, or 4,540 above the last enumeration.

The district includes three main valleys, giving passage respectively to the Garrw, the Ogwr, and the Ogwr Fach streams; each separated by high hills of Penant sandstone, and sloping towards a junction to the south. The Garrw and Ogwr valleys, running north and south, are deep and narrow; contain populous villages at intervals, and possess railway communication. The systems of main high roads and of railway lines are on much the same plan. The point from which the railway lines to the two valleys diverge is near Blackmill; for the combined line with the Maesteg valley line there is another junction at Tondû (Aberkenfig, in the rural district) some two miles below; and another, for both these with the main Great Western line at Bridgend, three miles further south again. The third, or Ogwr Fach valley, bends away from Blackmill to the east. It contains only one small village, Gilfach Goch, near the summit (only one-half of which is in this registration district, the other portion being in Pontypridd), and has no railway line.

The houses in the Ogmore and Garrw valleys stand chiefly in terraces on the steep banks, where the valleys are deep and narrow. The Penant sandstone is the geological formation, overlaid, where the houses stand, by alluvium near the river level, and above by broken sandstone and débris of the hill sides, or occasionally by peat. The soil is often damp and boggy. The principal villages are as follows:—

In the Garrw valley, Blaengarrw, at the summit, about nine miles from Bridgend, population 1,500; Pontycymmer and Ponty Rhyl, one to two miles below, combined population, 3,000. In the Ogmore valley, Nantymoel, near the summit, about nine miles above Bridgend, with Blaenogwr and Abu just below, population 3,000. Twnewydd, a mile lower in the valley, population 2,400. At Gilfach Goch, in the third valley, the inhabitants within this urban district (and within the registration district) number about 500. The remainder of the population, some 1,000, is collected in smaller hamlets and scattered localities.

The villages named are purely industrial, and much of the house property belongs to the large companies whose coal mines, &c., afford employment. At the summit of each of the larger valleys waterworks have within the last few years been established by private companies, and the mains are carried to each of the populous villages there situated, although a number of the houses are still unsupplied. At Gilfach Goch a similar work might easily be accomplished, but as yet the inhabitants depend upon the natural flow of water from the hills, and this in summer is apt to fail.

The sewage, or such of it as gets removed from the neighbourhood of dwellings, practically all finds its way into the streams. Of the 1,760 houses in the larger villages, nearly a thousand are provided with water, or syphon closets; 470 with cesspit closets, many of which have overflows to the drains, and the remainder (about 340) with pail closets. Slops and other liquid refuse, including drainage from piggeries, slaughter-houses, &c., find their way, as a matter of course, in the same direction.

The sewers have been constructed by the owners of the house property, and vary as to capabilities and quality in the different localities. At Blaengarrw, a new village belonging for the most part to the Ocean Company, a complete system of what are reported as well constructed, although unventilated, sewers has been provided. The sewage is discharged directly into the stream, and four-fifths of the houses are provided with water-closets having flushing apparatus. In the remaining villages the sewerage is piecemeal; natural water courses and storm-water drains are, as far as possible, made use of; much sewage is allowed to flow over bare surfaces, and the banks and sides of the streams are filthy with imperfectly removed sewage. The private drains, too, are often dilapidated and otherwise defective, allowing the surface about dwellings to become sodden. Few streets have been taken over by the authority, and, except for the main highways, the roads are deep in mud.

This condition of drainage exists to a dangerous extent at Pontycymmer, Nantymoel, and Tynewydd. At Pontycymmer, in addition, a large number of utterly neglected pail closets are in use. The emptying of pails is left to the tenants, and their only practicable plan is to bury the contents in their tiny plots of garden ground, usually uncultivated and often rising steeply from the backs of their houses, or descending steeply to those of their neighbours. I am told that after heavy rains it is not infrequent to find excrement washed down to the very doors of the dwellings. In this place, Pontycymmer, typhoid fever is indigenous. Dr. Parry, who practices here, tells me that he is rarely without cases under his charge, while the better-drained village of Blaengarrw above remains entirely free. At Tynewydd, in the other valley, the same disease has, under somewhat similar conditions, made its appearance repeatedly in recent years.

Since the establishment of the Local Board district the removal of ashes and house refuse has been undertaken by the authority, with great advantage.

A large proportion of the houses in the district are modern and built in the style of modern colliery houses in Glamorganshire—five-roomed houses, or two rooms on the ground floor and three small bedrooms above. Dampness is a somewhat common feature from the necessity or habit of building the houses on the damp and unprotected hill-side; and from the nearness of the steep bank at the rear, deficient ventilation of the lower rooms is occasionally observed. This latter condition was very marked at certain houses I visited at Abu, where the door of communication between the front and back rooms had been closed in order that one house might be converted into two tenements. The back dwellings thus formed, from their closeness to the bank and absence of through ventilation, were unfit to be occupied.

The practice of taking lodgers is almost universal in the district, and requires to be carefully regulated. No byelaws have been made by the sanitary authority with regard to houses let in lodgings.

The means adopted for preventing the spread of infectious disease are as inadequate here as in the other districts, and consist merely in the gratuitous provision of disinfectants in cases that happen to come under the notice of the sanitary officials.

Administration.—The financial condition of the district appears to be excellent. The rateable value is some 45,000*l.*; as yet no loans have been contracted, and the amount obtained from a rate of 1*s.* 6*d.* in the £ after paying establishment charges, has hitherto been devoted to extensive improvements on high roads which had fallen into bad condition. It is intended now to require the paving, channelling, &c., of many private streets preparatory to taking them under the authority's control; and plans are soon to be prepared for the proper sewering of Nantymoel. Byelaws, based upon the Board's model, have recently been confirmed, and the authority are now making regulations under the Dairies and Milkshops Order. It will be seen that a very large amount of most important work is falling, and about to fall, upon the surveyor. That officer holds the dual appointment of surveyor (including the charge of roads and highways) and inspector of nuisances, and of the roads alone there are some 40 miles in the district. He receives a salary of 60*l.* as inspector of nuisances, 30*l.* as surveyor, and 10*l.* as inspector of dairies, and is required to pay his own travelling expenses. He has one assistant, a working man paid in weekly wages. It seems more than probable under the circumstances narrated that the proper work of the inspector of nuisances will have to be neglected for the exceptionally pressing duty of a surveyor in a new and rapidly increasing district. It was obvious in fact, during my inspection, that this difficulty had already become serious.

The medical officer of health, Dr. Thomas, was appointed by the present authority in April 1888, until the 27th April 1889, at a salary of 25*l.* per annum, one-half of which is repaid from the Parliamentary grant. The same officer held the appointment under the rural authority, and his reports then showed fair appreciation of the sanitary necessities of the district; although they were, as he himself admits, almost entirely without result. To the present authority he had not up to the time of my visit reported on the condition of the district in general, but had confined himself to the notification of two outbreaks of disease (one of typhoid fever and the other of scarlatina), making in

connexion therewith certain recommendations as to the drainage and house accommodation severally of two localities. He was about also to make a representation to the authority as to the very grave sanitary defects existing at Blaengarrw; he proposed to attend personally the authority's meetings.

Cowbridge Urban Sanitary District.

The little town of Cowbridge is an ancient borough, once enclosed within town walls. Its first charter of incorporation dates back to the times of Charles II., but no sanitary functions were exercised by the Mayor and Corporation until November 1st, 1887, when the town was incorporated under the Municipal Acts; until then the rural sanitary authority exercised jurisdiction.

It is a market town and centre of an agricultural neighbourhood, and moreover possesses an important grammar school, besides two or three private boarding schools. The area is very limited, consisting of only 84 acres; and the population, which is almost stationary, is 1,337.

The town is situated near the south-eastern boundary of the registration district; seven miles by road from Bridgend, or by rail about 13 miles. Geologically it stands at the edge of the lias and mountain limestone formations, and chiefly upon a thin alluvial soil. A little stream, the Thaw, crosses the main street, and for a short space skirts one border of the district.

Locally the town is spoken of as consisting of the east and west villages, but in the village street, some three-quarters of a mile in length, the houses are continuous, and these, with a few short cross rows on either side, constitute the town.

The water supply is derived chiefly from three public wells; one in the centre of the town fed by water piped from a spring in the neighbouring field, another a little distance beyond the line of houses on the west, and a third in the east village. This latter is spoken of by the inhabitants as giving water offensive to taste and smell. It stands in the immediate vicinity of cesspools, and its use is no doubt most dangerous. A fourth well has recently been sunk at a new cattle market, but this, like the most satisfactory of the old supplies, is a little to the west of the centre of the town.

Such sewers as exist are of very rude construction, consisting chiefly of the old stone highway drains. In the east village and in the further portion of the west (about one-third of the town), even such channels are wanting, and the slop-water flows down dilapidated surface gutters in the streets, or is thrown anywhere about the premises.

The sewers discharge into the little river Thaw, at a part spoken of as the Poplar Pool, 200 yards or so from the centre of the village, and somewhat nearer the grammar school and other houses. In summer the water here is almost stagnant, and at Poplar House, close by, used as a private day school, the inmates complain of its offensiveness. Moreover, within a mile of its course the stream traverses the village of Llanbleithan, in the rural district, where some of the inhabitants complain of, while others drink, the water. The Cowbridge authority have lately, in direct contravention of the provisions of the Rivers Pollution Prevention Act, and of all sanitary proprieties, greatly added to the pollution of this pool by constructing a new pipe drain from the cattle market to empty into it.

A few pan and water-closets are connected with the sewers described, but for the most part excrement is disposed of in cesspools. The latter are made large and deep, and with a view to the soaking away of their contents. They stand often close by and even against the walls of

houses, and when full the excavation of supplementary holes appears to be commonly preferred to the removal of the accumulated filth. Privy accommodation of this sort is not only still provided by private property owners and builders, but is that chosen by the authority. For certain tenemented property belonging to the Corporation in Church Street, close by the large grammar school, large new cesspools of the kind, 5 feet square by 4 feet deep, had, I found, just been sunk within some 22 feet of the houses; and this in a yard the level of which is above the level of the ground floor of the houses. Next door to this property, in a house-yard only 11 feet square, a deep cesspool was excavated about two years ago, and the medical officer of health tells me that since that date there have been amongst the inmates of this house three attacks of "croup," repeated attacks of gastro-enteritis, one of true diphtheria, and a death from "epidemic pneumonia."*

The authority make no provision for the removal either of excrement or house refuse. The nuisances from cesspools, middens, and other accumulations of filth (from ill-kept pigsties, &c.) are in Cowbridge exceptional, both in number and extent, even for this registration district.

Much of the small house property is of a wretched description; the houses being small and ill-ventillated, dilapidated, exceedingly damp, with ground floors below the level of the unpaved and filth-sodden surface outside. In a row of nine cottages in the main street of west village, known as Llewellyn's Row, which to a casual observer, and from the street, may look fairly comfortable, but to which the above description will categorically apply, I collected the following history of recent sickness:—House occupied by one Thomas, two deaths from "croup," one in March 1887, one in February 1888; house occupied by Lovel, case of "croup," August 1888; house occupied by Neat, two attacks of gastro-enteritis, July 1888; house occupied by Williams, death from scarlatina, November 1888. In Mrs. Neat's house there was the only drain that I found about the premises, and that had been stopped for two years. One house was overcrowded.

There are three registered lodging-houses in the district. In the matter of privy accommodation they are all badly provided, and the room ventilation in all is defective. Two appeared to be on occasions overcrowded.

The authority possess no means of isolating infectious disease, nor have they any disinfecting apparatus. At the time of my visit diphtheria and scarlatina had just broken out. So far as could be ascertained, eight or nine households had been invaded, and amongst them a single case of diphtheria had occurred in each of two large boarding schools. The remaining pupils of these schools, some of them possibly already infected with the germs of diphtheria, were thereupon distributed to their homes—a necessity perhaps, under the circumstances, but a dangerous one, and one that need not have been incurred had proper means been available in the district for dealing with infectious disease.

It would appear that the authority have never fully realised their responsibility in this matter. The inspector of nuisances appointed for the town is a dairyman; and has been engaged of late alternately about infected premises and in the manipulation of milk. The authority have made no arrangements with the district registrar for the supply of mortality returns to the medical officer of health; and as the latter receives little assistance from his medical colleagues, there can be no

* The agent of this property is stated to be a member of the sanitary authority. Verity's Court, referred to on page 351 of the report, as well as other property in the town of a similar character, likewise belongs to one of the members of the authority.

assurance that prompt information, even of fatal outbreaks of infectious disease, will be forthcoming to guide the authority's action. I requested the town clerk to direct the authority's attention to the defenceless position in which the town was placed.

Administration.—Under the rural authority nothing whatever appears to have been done to amelioriate the evil conditions existing in this town. The medical officer of health of that time had indeed reported that "he could find nothing [of sanitary defects] worthy of mention;" and on another occasion, when one quarter's death rate chanced to be low, that "the district was the healthiest in the kingdom." The present authority in March 1888 appointed Dr. Meller as medical officer of health for one year. The salary decided upon was at first 5*l.*, but, the Board objecting, no salary was assigned, it being understood that at the end of his service the officer should receive some remuneration. Dr. Meller has not yet reported on the sanitary condition of the town, but has notified the recent outbreak of disease. He states that he is never consulted by the authority, and the recent further pollution of the Thaw by the action of the authority, and the recent further construction by them of cesspools such as I have described, were without his approval. He has not, however, made any official representation on these subjects, nor on the disabling effect of the authority's failure to obtain returns of mortality, nor on the impropriety of employing in work about infected premises a man engaged in the milk trade. For the rest, it is not to be forgotten that much of the wretched house property in the town belongs directly or indirecty to town councillors. Certainly, sanitary organisation here must be regarded as in a very early stage of development.

I have described now the sanitary circumstances of the several districts contained within the Bridgend registration district. It will be seen that they have much in common, and that their interests are very closely interwoven. The reason given by the Bridgend urban authority for neglect to sewer this town may be misapplied, but it nevertheless expresses a hardship from which the inhabitants of the district suffer. It cannot be a matter of indifference to Bridgend that, within some eight or nine miles, districts, containing populations numbering already some 24,000, should be pouring sewage unpurified, and often containing the specific poison of typhoid fever, into the stream which flows through the heart of the town. These centres of population are not only rapidly increasing, but they will be forced by the necessity of self-preservation to perfect their local sewerage arrangements. At present the great bulk of the sewage is washed down to Bridgend only at times of flood (no one can look at the banks of the streams about Maesteg, or Pontycymmer, or Nantymoel, or Tynewydd, or Aberkenfig, without appreciating this), but year by year sewers of a more efficient kind with a more direct discharge into the rivers are being constructed; and unless a thorough change of system be made, the towns lower in the valley will soon have to bear the passage of large quantities of crude sewage, not only at flood times, but when fresh water in the river is reduced to a comparative trickle, and when the weather is hot and dry.

The interests of the Bridgend urban, the Ogmore and Garw urban, and the Bridgend rural districts are all in this matter identical. It is a matter of even more concern to Pontycymmer in the Garw valley, and to Tynewydd in the Ogmore valley, than it can be to Bridgend below, that Blaengarrw and Nantymoel respectively should cease to pollute the streams; it is of even greater importance to the inhabitants of Aberkenfig than to those of Bridgend that Maesteg should cease to pour crude and

often fever-contaminated sewage into the Llyfni; and as to the remedy, when the time comes for restoring the purity of these rivers, it may be found to the interest of all these districts to combine in carrying out one and the same scheme for this object.*

In matters of water supply, again, material interests in these districts are likely to bring about much in common. At the top of the Garw valley a water supply has been obtained, said to afford 3,000,000 gallons per 24 hours above the amount needed in that valley. Already the advantage of bringing this surplus supply to Bridgend has been considered, and I understand that notice has been given of the introduction of a Bill into Parliament for the forwarding of the scheme. If it be carried out, localities in the Bridgend rural district, now much in want of water, would soon be within reach of what has promise of being an excellent service. The scheme would unite in matters of water supply the interests of three, and these perhaps the most important, of the sanitary divisions of the registration district.

The natural configuration and circumstances of the district create the common interests named above, and there are others that might be most advantageously cultivated. Each district is urgently in need of means of defence against infectious sickness; and it would be found probably at once an efficient and economical plan to provide at some central spot (in the neighbourhood of Aberkenfig perhaps) an isolation hospital for the combined districts. Or again, to take a smaller though still very important matter, it is desirable that those having the charge of the public health in the towns should have some knowledge of the condition of the dairies in the immediate neighbourhood from which the milk supply is derived, and that they should become promptly aware of any occurrence on such premises of infectious disease.

It will be seen that with common interests so important and various in these several districts, a medical officer of health who shall comply with the terms of his appointment in "making himself acquainted with all causes affecting, or threatening to affect the health of his district," and in order that he may adequately fulfil his duties as the adviser in sanitary matters of the authority, must be prepared to take a comprehensive outlook, and to carry his observations far and closely beyond the limits of any one of these sanitary divisions. And this being so, the question naturally arises whether a combined appointment, or the appointment by the sanitary authorities severally of one man, ought not in the interests of the district to be made. The advantages of such an arrangement would be manifold, as will be apparent from a study of what has preceded, and I can discover no objection to it of the least importance. For the purpose in question the district lies within easy compass from a central point; there is no difficulty whatever in obtaining access to any one part within a reasonable time. The single inspector of nuisances for the rural district finds no difficulty in reaching all parts of that district from his residence at Pencoed, near Bridgend; and the surveyor and inspector of nuisances to the Ogmore and Garw local board finds it convenient to reside at Bridgend. It would not perhaps be possible to make a detailed inspection of two localities at different extremities of the district, or in different valleys, in one day, but there would be no probable necessity for such haste.

* Just above Bridgend there is a County Lunatic Asylum, where the arrangements for sewage disposal present a striking contrast to those thought sufficient for the towns and villages. There by proper arrangements the sewage of a place containing over 1,000 inmates is utilized completely, advantageously, and without the slightest nuisance.

No. 21.

Notes by Dr. Thorne Thorne on Recent Occurrences of Epidemic Cerebro-Spinal Meningitis in the Basin of the Mediterranean.

The first information as to any recent prevalence of cerebro-spinal meningitis which reached the Medical Department was contained in a report by Dr. B. Mercieca, of the Civil Hospital at Gozo, and which gave an account of the occurrence of this disease in February 1887 in seven members of a family consisting of nine persons residing in the village of "Ta Sannat," in the island of Gozo. Three of the family died. The symptoms in some of the cases were those of the disease in its simple form; in others it assumed the fulminant type, and although no definite cause could be assigned for the occurrence, the genuine character of the disease, as judged of both by the symptoms and the pathological appearances, was vouched for by, amongst others, Drs. Rudd and Coates, army surgeons, who had seen the disease in Dublin, and by Professor Pisani, who, in confirming the diagnosis, stated that "ordinary meningitis," in some cases associated with "extension of the head and slight "contraction of the dorsal muscles," had been somewhat more frequent than usual, and who added some account of an isolated case of cerebro-spinal meningitis which had occurred at about the same date in the island of Malta.

The next information was embodied in a report submitted by Dr. F. C. Heidenstam, C.M.G., chief medical officer for Cyprus, to Sir Henry Bulwer, High Commissioner for the island, on February 21st, 1888, which report was communicated by the Colonial Office to the Medical Officer of this Board.

In his report Dr. Heidenstam stated that "a malignant epidemic fever, "attended with lesions of the great nerve centres"—subsequently referred to as undoubted cerebro-spinal meningitis—had broken out at Nicosia about the first week in January 1888; that the epidemic was then confined to Nicosia, and to some villages in the Nicosia, Kyrenia, and Famagusta districts; that, at that date, 60 attacks had taken place in Nicosia, 18 having already terminated fatally; that the incidence of the disease had borne no relation to the social standing or the sanitary surroundings of those attacked; and that he had no evidence to show that the disease was communicable from person to person.

On receipt of this report in this country, the Secretary of State for the Colonies moved Lord Salisbury to have him furnished with information as to whether there had been recently other outbreaks of this disease in the Mediterranean, and whether the conditions of their occur-

rence had been made the subject of skilled investigation, and, if so, with what result.

In consequence of this, instructions were in April issued by the Foreign Office to Her Majesty's consuls at Mediterranean ports to furnish the information desired. By this means communications, at times embodying medical reports, were received from British consuls as to the following places :—Tripoli, Beyrout, Alexandria, Constantinople, Samos, Crete, Syra, Salonica, Greece, Corfu, Trieste, Istria, Pola, Malta, Tunis, Algeria, Sardinia, Ajaccio, Genoa, Nice, Marseilles, and Barcelona. The information thus obtained, along with further reports from Cyprus, was communicated by the Colonial Office to the Local Government Board, and has formed the basis for compilation of these Notes.

The information from a number of these places was almost or altogether negative. Thus, no cases of the disease had been reported at Tripoli, Constantinople, Syra, Salonica, Corfu, Tunis, Algeria, Ajaccio, Genoa, Nice, or Barcelona. From Beyrout it was reported that cases had occurred there, as also at Jerusalem, but no information concerning them was forthcoming. At Alexandria nothing was known of the disease since the occurrence of sporadic cases in 1876 ; and only three cases could be heard of as having occurred in Marseilles during the three years preceding the inquiry, and as to one of these cases the diagnosis was admittedly doubtful. In so far as Malta is concerned, the only occurrence reported has been already referred to.

The following is a summary of the information received from the other places named.

I. *Cyprus.*—On the 8th June 1888 a further account of the prevalence of cerebro-spinal meningitis in the island of Cyprus was submitted by Dr. Heidenstam to the High Commissioner. As to the commencement of the disease, it appears that several cases of minor severity had occurred towards the close of 1887, and it is believed possible that other cases of a sporadic nature may have taken place in remote villages without attracting any attention. The first attack which was identified took place in Nicosia on January 1st, 1888, and by the 26th of the month the district medical officer reported that he had met with 15 cases, and that attacks elsewhere had come to his knowledge.

Gradually the disease became more prevalent, and on the 8th of June it was reported that 273 cases, of which 85 had terminated fatally, had been heard of in the island, and that there was but little doubt that other cases, as to which there was no record, had also taken place. Of the attacks recorded the distribution was as follows :—There were 216 cases and 60 deaths in the Nicosia district ; 132 cases and 27 deaths having occurred in Nicosia itself, and the remainder being spread over 15 other towns and villages. There were also 26 cases and 12 deaths in five localities within the Famagusta district ; 28 cases and 11 deaths in the Kyrenia district ; and 3 cases with 2 deaths in the town of Larnaca.

The disease is reported to have prevailed somewhat generally in the lower lying quarters of the town of Nicosia, where the town wall and the overcrowding of houses on area prevent any proper movement of air ; and where the sanitary circumstances are influenced for evil by a moat containing stagnant contents and receiving sewage. Apart from these conditions it could not be discovered that ordinary local sanitary circumstances had any special influence on the incidence of the disease.

No English families and none of the troops suffered; and even as regards the natives, a few cases only occurred amongst the well-to-do, and in these instances the sufferers were in a debilitated state. The classes most attacked were those who were subject to the depressing influence of a diet insufficient both as regards quantity and quality; a bad harvest having largely operated to increase the number of those who were in a state of poverty and who subsisted miserably on an insufficient and insalubrious diet.

Adverting to an opinion which was obtained by some of the inhabitants of Nicosia from Professor Brouardel, of Paris, to the effect that the disease was "eminently contagious," Dr. Heidenstam says that the circumstances of the prevalence in Cyprus failed to justify such a conclusion. Thus, "the inhabitants of the same house, and in many "cases of the same room, or even in some poor families, the occupants of "the same bed," as the sufferers were not affected. In only one case which came under his notice did two attacks occur in the same house, and these were almost simultaneous. The simultaneity of the beginning of the epidemic in different parts of the island under circumstances which did not admit of explanation by inter-communication, and the fact that the disease subsided at about the same time in all the places affected, are also referred to in the same connexion, although it is admitted that the latter consideration, especially, is of minor importance. Whilst admitting that the origin of the disease is extremely obscure, Dr. Heidenstam is induced to regard the disease as due to some "specific miasma" favoured by special conditions, amongst which he names temperature, and operating upon a people previously exposed to depressing influences.

Dealing with the symptoms, Dr. Heidenstam describes the disease as presenting very varying degrees of severity but being essentially associated with acute inflammation of the meninges of the brain and spinal cord. In some cases the more decided symptoms were preceded by a state of general mal-aise lasting from two to four days; but in the majority an initial "chill" was at once followed by vertigo, mental prostration, vomiting, and headache, which in turn were rapidly followed by intense cephalalgia, dry brown tongue, obstinate constipation, restlessness, confusion of ideas, and delirium more or less violent. About the third day contraction of the muscles of the neck set in, muscular agitation of the whole frame, with spasmodic contractions, trismus, local hyperæsthesia—or at times anæsthesia—and opisthotonus. In some cases there were affections of sight, paralyses, &c. Pulse and respiration became gradually more frequent, the temperature seldom rose beyond 103° Fahr., patches of purpuric ecchymosis were not unfrequent about the surface, and in the more severe forms, maniacal excitement preceded a condition of great bodily and mental depression, followed by a comatose state and death.

In some of the more malignant attacks death supervened in 24 hours; in others a remission of the initial symptoms gave rise to the idea that the disease had subsided, but within a short time the attack again became well-marked. A chronic type of the disease was also observed, and in some of these cases the patient ultimately succumbed as the result of gradually increasing exhaustion.

At the commencement of the epidemic, and to a lesser extent during its continuance, persistent and exceptional headache, lasting for several days, was met with; these attacks being regarded as minor ones of the same type.

The principal post-mortem signs were hyperæmia of the membranes of the brain and spinal cord, hæmorrhagic deposits on the dura mater, exudation of yellow lymph and at times of pus over the surface of the pia mater, both on the upper and lower surfaces of the cerebrum; serum was found in the arachnoid, and in the cerebral cavities, the spinal medulla being infiltrated with it, and the central canal being at times filled with a purulent fluid. On the surface and in the vicinity of the ventricles the brain substance was found to be pulpy. The intestines were generally congested and filled with semi-fluid fæcal matter, but no lesion of Peyer's patches was observed.

From a communication presented by Dr. Derbys, of Nicosia, to the *Académie de Médecine*, Paris, it would appear that the epidemic was mainly confined to the months of January, February, and March; that the season was a rigorous one in point of cold and humidity, and that the intensity of the epidemic during that period varied considerably according to the prevailing meteorological conditions. Thus it underwent a material increase during the prevalence of cold and humidity, and it sensibly diminished during periods of warmer and dry weather.

From an experience of some 70 cases Dr. Derbys states that the disease attacked, 1°, the poorer classes; 2°, those inhabiting damp and badly ventilated dwellings; 3°, those in small houses, where a single room had to serve for several persons; 4°, the inhabitants of the lower part of the town; 5°, persons having no means of protecting themselves against the inclemency of the season.

Referring to the means by which the disease diffused itself, Dr. Derbys thinks that the cause was one capable of spontaneous development under special conditions of climate, and that the malady acquired a greatly increased intensity in the presence of faulty sanitary circumstances. He also holds that the extension of the epidemic took place apart from all "contagion and transmission," and he adds that although he met with a number of instances in which persons, and especially the parents of the sick, were in contact with the sufferers, and even slept with them in the same bed, he met with no instance in which the disease could be regarded as contagious.

It would appear (Bulletin de l'Académie de Médecine, Séance du 22 Mai 1888) that the Académie de Médecine, on being applied to, had advocated the isolation of the sick and the disinfection of all affected linen, &c. From Dr. Heidenstam's report it would appear that though disinfectants were used in connexion with a system of nursing, medical and other help organised by the Government, and of food supplies provided by private benevolence, an attempt to organise a hospital was abandoned because it seemed quite evident that under the circumstances of the epidemic there was no chance of the inhabitants submitting voluntarily to any such measure of isolation.

The principal symptoms met with by Dr. Derbys were as follows:— 1°. Painful swellings and affections of the joints, particularly of the knees and wrists, both in the initial and later stages of the malady. 2°. Paralysis, hemiplegia, especially in the fulminant attacks. 3°. Strabismus, commencing during the first week. 4°. Choroiditis in one case of a girl of 13 years, beginning on the third day and ending in complete blindness. 5°. Herpetic patches in all cases, and appearing during the first week. 6°. Aphasia appearing in three cases on the third day. 7°. Hyperæsthesia (cutaneous) of rare occurrence. 8°. Diplopia in three cases. 9°. Amblyopia; dilatation of the pupil in all cases.

10°. Deafness at any, or during the whole, period of the malady. 11°. Habitual constipation. 12°. Partial and general muscular contractions with convulsive attacks of great violence. 14°. Temperature and pulse, irregular.

Treatment.—Dr. Heidenstam reports that various methods of treatment were adopted, and that those which appeared to be most useful were as follows:—Calomel in purgative doses; cool applications to the head; and, in the case of patients of strong constitution, leeches behind the ears, at the commencement of the disease; hypodermic injections of morphia to relieve pain; and antipyrine. The treatment referred to by Dr. Derbys was, in most respects, very similar to the above; hydrate of chloral and bromide of potassium being also referred to as useful to relieve delirium, insomnia, cutaneous hyperæsthesia, &c. Antipyrine was, he observes, only available at a late stage of the epidemic, but when given every two hours in doses amounting to two grammes a day for not more than three consecutive days it is stated to have materially diminished the cephalalgia, to have reduced the temperature by one degree (? Fahr.), and to have given substantial relief by inducing an abundant perspiration. In the "abortive" form of the disease, antipyrine gradually increased up to two grammes a day, and used at first in connexion with cathartics, was found to stay the violent cephalalgia, and to relieve the pain at the back of the head and neck. Under the treatment specified the mortality did not exceed 25 per cent. of attacks; and from such experience as was available Dr. Derbys is inclined to regard antipyrine as a true specific in cases of cerebro-spinal meningitis.

II. *Samos.*—The information received from the Island of Samos, off the western coast of Asia Minor, comes in the form of a report by Dr. Philoctete Nigra. According to this report cerebro-spinal meningitis made its appearance in the village of Mytilinous towards the end of February 1888; and it is stated that, so far as can be ascertained, the disease had previously been unknown in the island.

Mytilinous is described as a village of 4,000 inhabitants, and as one of the most populous places in Samos. The village lies on and entirely covers the northern slopes of a low oblong hill, from the foot of which, and extending in a northern direction, is an undulating valley flanked, especially on the west, by high mountains. Flowing down the valley from the north-west to the south-east is a large mountain stream. By reason of its situation and height the village is exposed to a keen air; it is very cold in the winter, and inflammatory diseases are not unfrequent.

The water supply is abundant, and the general sanitary circumstances of the place are said to present no exceptional features; the inhabitants are as a rule abstemious and sober; they live largely upon wheaten bread, dried vegetables, cheese, and salt fish, but they rarely taste meat; they are, as a rule, comfortably circumstanced and clothed; and overcrowding does not prevail. The first to be attacked was a girl, aged 12 years, who was at the time regarded as suffering from simple meningitis, accompanied by contraction of the cervical muscles. A few days afterwards a young man of 25 years was seized with somewhat similar symptoms, to which were added severe rachialgia and convulsions, ending in death on the fourth day. He had been of strong constitution, but his illness commenced on the day following a night's debauch and drinking. A third case having much the same symptoms occurred just about the same date or immediately after (actual dates not specified).

Suspicion as to the character of the disease was by this time aroused, and the adoption of such ordinary measures of hygiene as are usual in the case of epidemics was at first advocated; but as no similar affection had been previously known either in the village or island, the authorities ordered that an autopsy of the first fatal case (apparently that of the young man aged 25 years) should be made; the result being that in the opinion of the several physicians who were present, the body exhibited all the usual pathological indications of cerebro-spinal meningitis. Sporadic cases continued to follow, and it was only by the end of March that the disease had disappeared. In all 13 cases occurred, all presenting remarkable uniformity in point of symptoms. Five of the attacks terminated fatally.

Briefly summarised the symptoms referred to were:—an initial rigor, more or less severe, nausea, vomiting, violent cephalalgia, both frontal and occipital; the rigor was often followed by perspiration and elevation of temperature to 40° Cent., with such subsequent temporary abatement or intermission of symptoms in certain cases as to give rise to the view that the disease was malarial, and to lead to the administration of large doses of quinine. Such treatment seemed however useless, for the symptoms returned the next day accompanied by periods of excitement and depression, obstinate constipation, insomnia, rachialgia, muscular contractions, especially affecting the cervical region and the eyeballs, contraction of the pupils, pain and numbness of the extremities, involuntary evacuations, &c. Amongst the more occasional symptoms were intense delirium, aphasia, paralysis of one or other extremity, and emaciation in prolonged attacks.

The principal treatment is stated to have been antiphlogistic in character. Leeches were applied to the mastoid processes, cupping of the nape of the neck was resorted to, cold applications and at times blisterings were applied to the head and spine; whilst calomel and iodide of potassium were administered internally. Considerable hesitation is felt by the reporter in expressing an opinion as to the results of any treatment adopted.

Dealing with the causes of the disease, Dr. Philoctete Nigra regards them as involved in considerable obscurity. Whatever the "morbific cause," it is held to have been a local, and not an imported, one, and as the results showed it was altogether limited to the one village of Mytilinous. On the whole the view of some morbific poison acting aërially and perhaps favoured by some special climatic and meteorological conditions of the village, is regarded as best explaining the outbreak; and to the generally fair sanitary circumstances of the place is attributed the fact that the disease was so limited in extent. Northerly winds, to which the village is so much exposed, had been prevalent early in the year, and the influence of this wind upon inflammatory affections, whether simple or otherwise, is referred to. The catarrhal element of some such affections is spoken of as possibly favouring the operation of any specific agent, much in the same way as gastro-intestinal catarrh may influence the reception and action of the cholera poison. The rainfall of the season is stated to have been normal and sufficient in quantity; and no meteorological phenomena were regarded as being exceptional.

It is added, that in no case was the disease communicated to those who were about, or who tended, the sick.

III. *Crete.*—The only information from the island of Crete was to the effect that attention was first directed to cerebro-spinal meningitis

in January 1886, when it appeared at the village of Bahia, in the south of the district of Candia, four fatal attacks occurring within a few days. Since that date sporadic cases are stated to have occurred from time to time in other parts of the island, and especially on the south-west of Canea. The disease does not appear to have been made the object of particular study.

IV. *Greece.*—The information from Greece is also very limited. From the Piræus the British Consul, writing on 24th April 1888, states that both there and at Athens isolated cases of cerebro-spinal meningitis had occurred, but that the disease had not assumed any "alarming" signs of spreading, and hence that it had not been made the subject of any skilled investigation.

From Patras no recent prevalence of the disease could be heard of, but the medical practitioners within the Consulate stated that occasional cases did occur, principally amongst prisoners and the poorer classes who live near marshes and are both badly clothed and fed. The disease had, however, not hitherto been very fatal.

V. *Trieste and Istria.*—Information from Her Majesty's Consulate at Trieste on April 23rd, 1888, was to the effect that, according to the secretary to the Medical Association of Trieste, no epidemic of cerebro-spinal meningitis had occurred there for the past 10 years. But from further information obtained from the Provincial Sanitary Association, it appears that cases of that disease had occurred during the preceding February and March in various parts of Istria. Amongst the places specified are Pola, Gallesano a townlet immediately to the north of Pola, Dignano somewhat further to the north, and Confanaro. At Pola some 30 cases occurred. They are stated to have originated amongst the military, the disease subsequently manifesting itself amongst the ordinary population there and in the other places specified, and this under circumstances that made it impossible to prove that it had been transported either by persons or personal effects.

The total attacks heard of were 81 in number. Of these 19 cases occurred in adults and 62 in children under 14 years of age. Amongst the adults 7, and amongst the children 23, deaths occurred; there being thus in all 30 fatal and 51 non-fatal attacks. The earlier cases were the most severe and fatal, but towards the close of the epidemic, which was regarded as having come to an end at the date of the report, the attacks were at times so slight as to cause doubt as to the diagnosis.

Beyond a reference to a very damp, cold winter, no special cause was assigned for the epidemic.

VI. *Sardinia.*—According to a report by Professor Aresu, of the Sanitary Council of Cagliari, and dated 5th May 1888, cerebro-spinal meningitis has been observed in various communes of Sardinia during the past few years; Decimo-mannu, Assemini, and Terra-nova being specified amongst the places which have been affected. And as regards the first-named two places it is said that cases had occurred there during the early months of the year, and that the deaths amounted to 30 per cent. of the attacks. At Terra-nova, however, it is believed that all the cases proved fatal.

Referring again to Decimo-mannu and Assemini, Professor Aresu says that the cases were limited to a small area, and in this connexion he notes that the patients were isolated and that carbolic acid was applied as a disinfectant as regards houses, clothing, bedding, &c.,

dejections, and the bodies of the dead. In both villages the disease is stated to have appeared after the occurrence of some epizootic, during which the inhabitants used as a food the flesh of the diseased animals.

In the fulminant cases the malady was at times of only a few hours' duration; in chronic cases it had lasted from three to four months.

With regard to treatment, the application of ice or cuppings to the back of the head and spine, purging by calomel, inunction of mercurial ointment, and iodide of potassium are spoken of as credited with good effect. Quinine was also in some cases administered in small doses and for long periods. The strength of the patients was mainly maintained by soups and wine.

No reference is made to symptoms, pathological appearances, or probable causation.

APPENDIX B.

No. 1.

I.—Further Report on Eruptive Diseases of the Cow; by Dr. Klein, F.R.S.

Further Report on Eruptive Diseases of the Cow; by Dr. Klein.

In last year's (1887) report three different eruptive diseases of the teats and udders of cows were considered in reference to certain of their differential characters, namely :

1. The Hendon disease, as to which in 1885–86 its relations with human scarlatina had been in micropathological respects fully discussed ;

2. A contagious eruptive disease of the udder and teats of certain Wiltshire cows, known to have communicated to the hands of milkers a certain vesicular eruption. Of this disease it was shown that in its pathology, as studied in the cow and in the calf (to the latter of which it had been experimentally transmitted), it differed markedly from the disease observed in 1885–86 amongst the cows at the Hendon farm ; and,—

3. A definite eruptive disease in the teats and udder of certain cows in Edinburgh, which had been found by Dr. Cotteril to have stood in definite causative relation to febrile sore-throat in the human subject, viz., amongst the consumers of the milk of these cows. Of this "Edinburgh disease," it was shown that in its pathology, as also in its clinical manifestations on its transmission to the calf, it differs both from the Hendon disease, and from the Wiltshire disease as described by Dr. Crookshank.

During the year 1888, I have had the opportunity of investigating several occurrences of eruptive disease on the teats and udder of milch cows in different parts of England, and on these I propose now to report.

A.—Kingston Cow Disease.

Udder eruption of Kingston cow.

This was an eruptive disease in the cow which proved communicable as a vesicular eruption to the skin of the milker.

In April 1888, I received information, through Dr. Shirtliff, of a cowman at Kingston-on-Thames ill with a vesicular cutaneous eruption derived by him from a cow with "sore" teats. And on the 23rd of the month opportunity was given me of examining both the cow in question and the infected milker. The latter had been ill for three weeks with a febrile disorder associated with pustules and vesicles on the fingers and palm of the hand ; in the earlier stages of the eruption he had suffered from an inflamed arm and from swollen axillary glands. When I saw him there were still present in this case pustules as follows :—one on the forehead, one on the lip, and several on the fingers and the palm of one hand. Other pustules had become crusted over and were healing. Some of the most recent,—though said to be of three weeks standing,—

measured about $\frac{1}{8}$–$\frac{1}{4}$ inch in diameter; they were round, black, umbilicated in the centre, and had pale raised vesicular margins. There was no areola around them. The crusted pustules were acuminated, hard and black, with small pale periphery. The cow,—a black Alderney,—had a fine coat, and was said to be in good health; she gave plenty of milk. On the udder she had some small flat ulcers covered with thick brownish black scabs; other ulcers on the udder, covered with thin scabs, were evidently healing. The scabs of these were partially loosened, and the sores underneath were seen to be superficial and contracting. Upon all four of this cow's teats were large flat irregular superficial ulcers covered with brownish black scabs. These were firmly adhering to the ulcers, and when forcibly removed superficial bleeding sores were exposed. The size and character of these sores and scabs on the teats are shown in Figs. 1 and 2. When first I saw this cow, the sores, covered with brownish black scabs, were stated to be about three to four weeks old. A companion cow had also been suffering from eruption on the teats and udder, but she had been already sold by the owner. Both cows had been bought at Reading market, and both had since been under the care of the milker above referred to. No case of scarlet fever had been heard of as occurring amongst the consumers of the milk of these cows.

This Kingston cow was purchased and removed to the Brown Institution, where the animal was kept under observation for many weeks. About four weeks after I obtained the cow, *i.e.*, about eight weeks since the fully-formed ulcers and scabs had come first under observation, the udder and teats had become quite clean, and the ulcers had quite healed up. But not till about the end of the sixth week after the first appearance of the sores on the teats, did the scabs which formed on them become detached and fall off. As soon as all the teats had become quite clean, this cow was from time to time carefully examined in order to observe the manner in which the cicatrices of the ulcers altered; but after a week no trace of any cicatrix either on the udder or on the teats could be detected.

I do not find any great resemblance between the eruption on this Kingston cow's teats and true cowpox as described by Jenner and Ceely. The aspect and particularly the course of the eruption on the teats of the Kingston cow did not correspond with Jenner's or Ceely's description. The superficiality of the ulcers, the long duration of the firmly-attached scabs—adherent for at least six weeks after the sores came under observation,—and the absence of scars a few weeks after the scabs had fallen off, seem to me characters whereby this Kingston disease may be differentiated from true cow-pox. Similarly in this case, the eruption in the milker had only a superficial resemblance to vaccinia transferred to the milker, such as we know it from Jenner's and Ceely's descriptions. In the Kingston milker some of the eruption was, as in vaccinia, umbilicated, and had black centre and pale vesicular margin; but altogether unlike vaccinia this condition of the eruption had persisted for three weeks. On the whole, I do not find ground for considering this eruption in the Kingston milker as "vaccinia."

On the other hand, however, the eruption on the Kingston cow coincides in a remarkable manner with the Wiltshire disease, which, as stated in last year's report, I have had the opportunity of studying in two cows. In the matter of size, shape, aspect, and in the superficiality of the ulcers; in the slow progress and long adhesion of the scabs; in the absence of scars a few weeks after separation of the scabs; and in the

fact that the eruption of the cow's teats was communicated to the milker's skin,—the maladies have much in common. As will be presently shown, experiments on calves made with the scabs and scrapings of the ulcers of the Kingston cow go to confirm the inference as to the identity of the two maladies.

1.—*Experiment on Calves with Crusts of the Kingston Cow.*

Transmission of Kingston malady to calves:

Crusts were removed from the ulcers on the teats, and matter was, at the same time, scraped off from the surface of ulcers that were in a state neither of advance nor retrogression. With a mixture of both I inoculated, in about 50 incisions of skin of groin and abdomen, three calves, Nos. 1, 2, and 3. My notes thereon read as follows:—

*3rd day**:—All incisions "taken." They are slightly swollen and distinctly red; redness surrounding them for about $\frac{1}{8}$–$\frac{1}{4}$ of an inch. Along the middle line of the swollen incisions there is a thin brown crust by which the incision is closed, and immediately around this linear crust there is in some incisions an indication of vesiculation.

4th day:—The swelling and redness is more pronounced, and most of the incisions show alongside the central thin crust distinct vesiculation; the vesicle being in some about $\frac{1}{8}$–$\frac{1}{4}$ of an inch in diameter. When pricked, a droplet of lymph oozes from the vesicle; this fluid is slightly turbid. (*See* Figs. 3 and 4.)

5th day:—The vesicles still distinct: so is the swelling and redness; the fluid in the vesicles is purulent.

6th day:—The crusts are thicker, the vesicles diminishing and becoming themselves also crusted.

7th day:—All incisions are covered with thick dry crusts.

8th day:—Crusts still increasing.

9th day:—The crusts are in a few places seen to be diminishing and to be getting loose; the redness has by this time quite gone. When the crusts are taken off a superficial bleeding sore is exposed.

10th day:—Crusts that were yesterday removed from some incisions have again formed.

11th day:—The new crusts still enlarging.

12th day:—Status identical, except that the crusts generally are distinctly decreasing in diameter.

13th day:—Crusts begin to get decidedly loose and to come off easily, leaving a contracted sore behind.

14th day:—The healing of the sores and the falling off of the crusts progressing.

Comparing these results with those described by Dr. Crookshank as obtained by him in his experimental inoculation of calves with matter from the sore teats of the Wiltshire cows (*see* Report by Professor Brown, 1888, pp. 13 and 14), their similarity is very striking.

2.—*Experiments on Calves with Crusts of above Experimental Calves.*

its further transmission from calf to calf.

With crusts taken on the 6th day from some of the incisions of one of the above calves, I inoculated two calves, Nos. 4 and 5, in 20

* The second day signifies throughout these papers the calendar day next succeeding the operation; and in like manner the third day is the calendar day thence following; and so forth.

insertions (some incisions, others punctures) of the skin of the groin and abdomen,—with results as follows:—

3*rd day*:—The incisions are red and swollen.

4*th day*:—There is distinct indication of vesiculation; the swelling and redness are at the same time increased.

5*th day*:—Crusts covering the incisions are distinctly thicker and broader.

6*th day*:—Redness is still increasing; crusts have much increased in breadth and thickness. On removing a crust a flat superficial sore is exposed which is covered with a thick film of purulent matter.

8*th day*:—The crusts are thick and yellow-brown, still progressing. New crusts have formed on the ulcers from which yesterday crusts were removed.

10*th day*:—Redness has subsided, and the crusts have not enlarged; the sores seem to be contracting.

12*th day*:—Healing has commenced; crusts loose and underneath them are contracting ulcers. These ulcers are distinctly less moist than on 10th day.

13*th day*:—The process of drying up and healing is very pronounced.

These results harmonise then in all essentials with those obtained in the first three calves which were inoculated directly from the Kingston cow's ulcers.

3.—*Further Experiments on Calves with Crusts from the Kingston Cow and an Experimental Calf.*

A calf, No. 6, was inoculated in 35 incisions with crusts from a teat of the Kingston cow on May 2nd, *i.e.*, about four weeks and a half after the sores were first observed on the cow.

The course of these insertions was exactly the same as in the first three calves, except that in calf No. 6, the intensity of the process,—swelling and redness on 3rd day, vesicles on 4th day, thick brown crusts on 7th day, enlarging for some days afterwards,—was very pronounced.

A further calf, No. 7, was inoculated on May 2nd. On one side (in groin) with crusts from the cow's ulcer, on the other side with crusts from calf No. 1, taken on the 8th day from one of its ulcers. The result was uniform on both sides and very striking indeed, being by the sixth day very intensive (*see Fig.* 5), and leading to the formation about the 8th day of thick brown crusts $\frac{1}{2}$–$\frac{3}{4}$ of an inch in breadth. These did not show any abatement in growth or any looseness till the 12th day. On the 13th day the process of commencing healing was pronounced, and it was complete by the 18th day.

4.—*Re-inoculation Experiments.*

Re-inoculation of Kingston calves.

Calves No. 2 and No. 3 were re-inoculated on the 14th day of their induced malady, *i.e.*, at a time when the first process had not quite disappeared; all crusts of the first inoculation had not yet fallen off.

The material used for re-inoculation of calves Nos. 2 and 3 were crusts taken on the 8th day from the induced sores of calf No. 7.

The result was what might have been anticipated, viz., the animals proved only incompletely protected. In both calves the incisions "took," but the process was accelerated; redness, swelling, and commencing vesiculation were observed as early as the second day, and on

the third day the process was more pronounced. But on the fourth day retrogression had commenced; the vesicles having become crusted. On the 5th day the crusts had not further enlarged, while the redness was quite gone; some of the crusts too were becoming loose. On the 7th day most of the crusts had fallen off, leaving dry sores behind. On the 9th day all crusts had fallen off, and the sores were nearly healed.

These same two calves, Nos. 2 and 3, were, after the lapse of a fortnight, once again inoculated with crusts of the Kingston cow's ulcers as well as with crusts preserved from calf No. 7. But no re-action followed.

In none of the foregoing calves, one or two weeks after the sores had completely healed, was there any sign of cicatrices or pitting. Immediately after the crusts had become detached and had fallen off, the sites of the sores were indeed occupied by slightly raised whitish brown linear cicatrices, but after a few days the skin became again nearly smooth, and the linear cicatrices quickly disappeared.

5.—*Further Experiments of Re-inoculation.*

The sores of calves Nos. 4, 5, 6, and 7 were allowed to completely heal up, and a week or two later these calves were re-inoculated in over 50 incisions each, with crusts and points that had been taken on the 8th day from calves Nos. 4 and 7. The result of these re-inoculations was, as might have been expected, negative. These calves were found completely protected by their first inoculation.

From these experiments we learn then: that on inoculating calves with matter derived from the crusts and ulcers of the Kingston cow's teats, and taken at different stages of the malady, the same typical results are uniformly produced. They consist in the appearance of vesicles which commence on the 3rd day, and reach their full development about the 4th or 5th day. These vesicles then become converted into brown crusts which increase in breadth and thickness till about the 8th day, and afterwards diminish and get gradually loose, till on or about the 13th day the process of healing is established. An identical result is uniformly obtained if, for inoculation of the calves, crusts are used that have been taken from an experimental calf either on the 6th or 8th day. Calves that have gone through the experimental disease, and have been allowed to completely recover, prove insusceptible on re-inoculation. But calves which are re-inoculated before the first process has completely run its course show themselves incompletely protected; though they re-act again, the disease process in its repetition runs a much more rapid course than normally. From the uniform results obtained in calves inoculated from the Kingston cow's ulcer, and in calves inoculated with crusts from other experimental calves, I conclude that the course and progress in calves of the transmitted disease is typical of the Kingston malady, and I do not find indication of any but superficial resemblance of this malady to "vaccinia."

B.—Camberwell Cow Disease.

Udder eruption of Camberwell cow:

This was an eruptive disease of the cow, occurring sparsely among a herd of some three dozen of these animals, which furnished the milk of a certain dairy credited with having distributed, in the early days of May 1888, scarlatina to a limited section of its customers.

On 16th May I visited the dairy in question, and in a cowshed belonging to it, saw a cow on whose hind right teat there was an ulcerated round sore covered with brown crust, and about three quarters of an inch in diameter. This cow was also noticed to cough. The cow next to her had sores and scurfy desquamating patches in various parts of the skin of the body; and the next succeeding cow in the shed had on her right hind teat a cicatrix (or I should rather say a sore almost healed), of irregular shape, its broadest diameter a little over half an inch. I removed the crust from the first-mentioned cow,* and with scrapings of the sore thus exposed I charged several points.

Two days later I again saw this cow, and found the ulcer partially covered with thin brown crust; part, however, of the sore had become contracted and dry. On the next day the healing of the sore could be definitely pronounced.

transmission of the malady to calves;

On May 18th, I inoculated, with points and crust taken on May 16, two calves Nos. 10 and 11†, each in over 40 incisions in the skin of groins and abdomen; and subsequently I took notes as follows:—

3rd day:—The incisions are dry, not swollen and not red.

4th day:—All incisions in both calves seem to have failed.

5th day:—Calf No. 10 shows about a dozen incisions red and slightly swollen. Nothing in calf No. 11.

6th day:—Calf 10 shows 18 incisions either partially or wholly swollen and markedly red. The line of incision is occupied by a yellow brown crust. (Fig. 6.)

7th day:—In calf No. 10 the redness seems less around some of the above insertions, but they are still swollen and covered with thin crust.

8th day:—In calf 10 the redness from around all insertions has disappeared; also the swelling has gone down, but the crusts are broader.

11th day:—Crusts are still covering the 18 insertions. They had not quite fallen off, though many of them were loose seven days later. By this time, however, the sores were healing.

Calf No. 11 failed altogether.

its further transmission from calf to calf.

On May 24th, *i.e.*, on seventh day, I took off some of the scabs of calf No. 10, and with scrapings of the exposed sores charged several points.

On May 25th, I inoculated with these materials two calves Nos. 12 and 13, each in 45 insertions in skin of the groins and abdomen. There was nothing noticeable in any of the incisions till May 28th, *i.e.*, the fourth day, when many of the insertions in both calves showed for the first time distinct redness of the skin immediately surrounding them.

5th day:—The redness more pronounced,—more so in calf No. 12 than in calf No. 13,—the majority of the insertions showing this redness and being at the same time slightly tumid. The line of incision is in each instance occupied by a thin scab. (*See* Fig. 7.)

6th day:—The redness and swelling has advanced. (*See* Fig. 8.)

7th day:—Further advance both of redness and swelling; and immediately at the side of the central scab there is seen in some of the

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* The cow owner (Mr. M.) informed me that this particular cow was milked the last of a series. His son and two other men besides himself attended to the cows and neither in his household nor in the families of his customers was there (so far as he knew) at this time any case of scarlet fever. None of these cow attendants contracted any eruption from the cow.

† (Calves 8 and 9 were used for another purpose: this is the reason why the above calves figure as 10 and 11.)

insertions a pale dot or a pale short line, as if indicating a commencement of vesiculation. (*See* Fig. 9.)

8*th day*:—Further advanced; vesiculation more distinct than yesterday (Fig. 10); nearly all insertions of calf No. 12 are decidedly red and swollen; in calf No. 13 this condition also distinct but not so intense. Thin crusts in the middle of the insertions.

9*th day*:—In some of the insertions vesiculation is fairly well pronounced, in others no appearance of vesiculation is noticeable; redness is still present but in some insertions has slightly diminished. Crusts have become broader and thicker.

10*th and* 11*th days*:—The redness has almost gone from all insertions; in none is there a trace of vesicle visible, but most of them are now covered with broad thick brown crusts. (Fig. 11.)

12*th day*:—Crusts have much increased in breadth and thickness; they are very firmly adherent. When lifted off a bleeding sore is exposed, somewhat indurated and raised.

14*th day*:—Crusts still progressing, those sores from which the crusts were removed on 12th day are again covered with thick crusts.

17*th day*:—For the first time noticed loosening of scabs. Underneath is a contracting somewhat dry sore, evidently healing.

20*th day*:—Many crusts are crumbling off; sores dry and healing, some almost healed. A week later all crusts had disappeared, the insertions were raised reddish cicatrices.

From calves Nos. 12 and 13, on the 8th and 9th days (June 1st and 2nd), crusts had been removed, and points charged with scrapings of sores. Both crusts and points were used on June 4th for inoculating two calves, Nos. 14 and 15, each in 40 incisions and several punctures. Nothing was noticed on the 2nd or 3rd days; but on the 4*th day*, that is on June 7th, for the first time all insertions were swollen and surrounded by redness. Later notes were as follows:—

6*th day*:—The insertions are much swollen, the redness very marked and extending to about one-eighth of an inch around the insertions; these are occupied by thick brown crusts. (Fig. 12.) No traces of vesiculation in any of the insertions in either calf; but in calf No. 15 there are several accidental (accessory) round raised red papules.

8*th day*:—The crusts are thick and about one-eighth of an inch broad; the swelling and redness are still distinct but less so than yesterday. In some insertions there are alongside of the scab indications of vesiculation, but on pricking them no lymph is to be got. Upon removing a scab a bleeding infiltrated sore is exposed.

9*th day*:—Thick brown crusts are renewed on those sores from which yesterday crusts had been taken. The other crusts are brown and have increased both in thickness and breadth; the latter equals about half an inch. The redness has further subsided. By the 10*th day* redness was not visible. (Figs. 13 and 14.)

Till June 18th, *i.e.*, till the 14*th day*, the crusts continued thick and broad and firmly adherent. On the 16*th day* some were commencing to get loose; underneath these the sores were dry. After this the crusts became brittle and gradually crumbled off, leaving (about 20th day) a dry raised reddish cicatrix behind. The cicatrices gradually became paler and flatter, and about 10 days to a fortnight later little or no trace of them could be recognised. Nor was there after a few weeks any trace of the cicatrices left in calves Nos. 10, 12, and 13.

With crusts of calf No. 15, taken on the 9th day, I inoculated one calf, No. 19, in 45 incisions. The result was identical with that in calves Nos. 14 and 15.

Re-inoculation of Camberwell calves.

These six calves, Nos. 10, 12, 13, 14, 15, and 19, were, after they had completely recovered, once again inoculated in many incisions with preserved crusts that had been removed from calves of this series on the 6th, 7th, and 8th days, and as well with scrapings of the sores dried on points. But they all completely failed to "take."

Comparison of Kingston and Camberwell maladies.

Comparing the disease in the Kingston cow with that in the Camberwell cow, we see some well marked differences by which I think the two ailments may be distinguished one from another.

1. In the Kingston cow we have numerous big superficial irregular shaped sores on the teats covered with irregular shaped crusts. In the Camberwell cow we have one big round sore with infiltrated basis covered by a thin crust.

2. In the Kingston cow the sores ran a very slow course, the crusts remaining on the sores for many weeks. In the Camberwell cow the sore ran a short course and healed up in a few days after it was first noticed or had commenced to be covered with crust. In this Camberwell cow the sore could not, when I saw it, have been of more than a week's standing, whereas in the Kingston cow the sores and scabs had notoriously been present for several weeks before the cow came under my observation, and after that they remained unaltered for several additional weeks.

In important respects there is a striking similarity between, on the one hand, the eruption on the teats of the Kingston cow and that in the Wiltshire cows of last year, and, on the other hand, between the eruption on the teats of the Camberwell cow and that of the Hendon cows in 1885-86. Further correspondences of a like sort between the several maladies are seen on their transmission from the cows to calves. On the one hand, the disease induced in calves inoculated with the matter derived from the sores of the Kingston cow bore a striking resemblance to that described by Dr. Crookshank as induced in calves inoculated from the Wiltshire cows. And on the other hand, the malady induced in calves inoculated from the Camberwell cow was precisely similar to that observed in calves (as described by me in 1886 report) inoculated from the Hendon cow. In any case the result of the inoculation of the calves from the Kingston cow,—as described in the previous pages, and illustrated in Figures 3, 4, 5,—is in every respect different from that obtained in Camberwell calves, as shown in Figures 6–14, and described also in the foregoing pages. The differences as to course and appearance of the induced maladies are so obvious that I need not again repeat them.

It has been shown in the experiments carried out on calf No. 10 with the crusts and matter derived from the Camberwell cow, that this cow was suffering from a communicable eruption; and this was fully confirmed by the further subinoculations from calf No. 10 of calves Nos. 12 and 13, and from these again of calves Nos. 14 and 15, and from the last of calf No. 19. Now, when the cow-owner (Mr. M.) at Camberwell learned that his milk was under suspicion of having caused scarlatina among his customers, he at once consulted a well-known and experienced veterinary surgeon, who having examined his cows (38) thereupon gave him a certificate that all the cows in question were at that date in perfect health. This certificate Mr. M. had lithographed, and copies were sent to all his customers, and as well exhibited in the window of his shop.

The cases and the certificate are interesting as bearing upon a statement that has been officially announced, that during an inspection made in 1887 "of over six hundred of the Metropolitan cowsheds, containing "more than nine thousand cows, * * * scarlatina was at the time "very prevalent in London, and it was thought probable that if the "udder disease had any relation to the fever in man, the London cows "might furnish typical examples of the Hendon cow disease." "Not a "single case was detected * * *."

In reference to this expectation, it is (1) to be observed that the milk produced by London cows forms but a fraction of the milk consumed by Londoners obtained from cows outside of London, which milk is in many instances (we are told by the same official authority), collected on "dirty premises," "from cows with diseased and dirty udders and teats." And (2) the non-detection of udder eruption in London cowsheds proves to be consistent with the fact that an experienced veterinary surgeon had examined the 38 cows at Mr. M.'s, and had certified them to be in perfect health, at a date on which one of these cows was affected with an eruption on the teat, unquestionably contagious, as was soon after proved by the inoculation experiments on calves Nos. 10, 12, 13, 14, and 15. Thus any inference derivable from the complete absence of any udder disease in the 9,000 London cows needs to be drawn with a considerable amount of reserve.

Nor is the above an isolated instance of confident declaration, which did not find its justification in fact, as to the perfect health of cows, on the part of an experienced veterinary surgeon. I append a second:—

At the beginning of July 1888 Dr. Ridge, Health Officer at Enfield, ascertained that at a certain cowkeeper's at Enfield two children had been attacked by scarlet fever, and that no cause could be assigned for their illness. Dr. Ridge at the same time learned that on this cowkeeper's premises a cow was suffering from a vesicular eruption on the teats.

On July 11 Dr. Ridge took me to see this cow. Upon its teats were two marks of ulcers, almost healed up. Besides this cow we found on the premises three others, on whose teats there were present several sores, covered with dark brown crusts, which were evidently contracting, and in the process of healing. Further, we saw there two additional cows, each of which had one big ulcer on a hind teat; each ulcer was round, about three quarters of an inch in diameter, indurated, elevated, and covered with amber-coloured crust and amber-coloured congealed lumps of lymph. When the crusts were taken off, raw bleeding sores were exposed. The ulcers of these two cows were evidently of recent date. So that besides the first cow, in which the sores had healed up, we found three cows with sores of some duration, and other two cows with recent sores, out of a total, if I remember rightly, of about a dozen cows kept there. Certainly the number did not greatly exceed a dozen; the cowkeeper, with one assistant, sufficed for the milking of them. It is quite clear from the above facts that there was present on these premises a contagious eruption on the cows' teats, and it is not therefore surprising that under the circumstances Dr. Ridge had stopped the sale of their milk. But a veterinary inspector had seen the first cow a few days prior to our visit, at a time when the ulcers were still unhealed, and had declared them of no consequence; "chapped teats," or something to that effect, was what he is understood to have called them. The other cows which when I saw them had healing and recent ulcers, he had seemingly overlooked altogether. In a word, this veterinary inspector failed to ascertain that in these sheds a contagious eruption had been progressing and spreading among the cows. This fact is especially deserving of attention, for it must be held I fear, to cast doubt upon a similar assurance given on high veterinary authority, as to the perfect health of Enfield cows on a previous occasion when milk at Enfield came under suspicion. The following are the terms in which this assurance was conveyed: "A "few months ago diphtheria appeared at Enfield. The medical officer

" (of health) reported that he felt justified in concluding that the " disease arose from the milk which was supplied from a certain " dairy. * * * Whether or not the milk had become in part contaminated " with the diphtheritic poison is not known; but, as usually happens now, " the cows fell under suspicion, and the owner's business was so much " damaged that he had to dispose of part of his stock. The cows were " subsequently examined by the Chief Inspector of the Agricultural " Department, and found to be perfectly healthy * * *."

C.—Alderley (Gloucestershire) Cow Disease.

Udder eruption of Alderley cow.

This was an eruptive disease in cows, communicable to the skin of the milkers, and resembling closely vaccinia.

During the first week of June 1888, I received information, through the Local Government Board, from Mr. Forty, medical practitioner at Wootton-under-Edge, Gloucestershire, that at a farm at Alderley an eruptive disease on the udder and teats was occurring amongst cows; and that the farmer's son and other persons engaged in the milking had contracted an eruption like that of the cows. The farmer's son had been for some days under the medical care of Mr. Forty, suffering from a vesicular eruption on circum-anal piles, resembling both in its course and aspect vaccinia.

Mr. Forty was good enough to take me to this farm at Alderley on June 8th, and there I saw the farmer's son, who, though still in bed, was convalescent. He had on circum-anal piles several sores, which were healing. The history of his case was this: He was one of the milkers, and on a certain Sunday towards the end of May, he, having just milked (or rather while engaged in the milking) one of the cows with sore teats, and having his hand contaminated with blood and matter from the teats, was suddenly, as he said, "taken short." At that time he was suffering from piles. On the fourth day afterwards he, feeling something wrong about these piles, sent for Mr. Forty to examine him. That gentleman found a papular eruption on and around the piles, and from that time forward had an opportunity of watching the changes of these papules to vesicles and the scabbing of these latter. As a result of his observations, Mr. Forty came to the conclusion that this eruption was indistinguishable from vaccinia.

I examined on this farm a number of cows with sores on the teats and udders. The sores were of various sizes and outline; mostly irregular, and covered with brown or black scabs. Some were recent (about one or two weeks' duration), others were of longer standing, namely, several weeks old. Those on the teats were as a rule larger and more irregular than those on the udder. Upon taking off a scab a raw bleeding surface was exposed. In some cows, some of the sores were healing or healed, while others were still covered with firmly adherent crusts.

I saw also at this Alderley farm several milkers who had had sores on one or more fingers; one had had a bad arm with swollen axillary glands. The farmer himself, as also all other persons that had milked these cows, had contracted the eruption; but at the date of my visit there were in these persons only slight scabs visible as the remnant of their sores.

A girl, about 20 years old, taking the place of a milker who on account of a bad hand had become incapacitated from milking, had necessarily to milk one or more cows which had sore teats. On June 1st she noticed

for the first time on the dorsum of the right thumb a red pimple, which enlarged during the next few days. When I saw this girl on June 8th there was present on the dorsum of her thumb a slightly raised circular vesicle, with dark centre and pale periphery; the centre of this vesicle was slightly depressed. It measured a little under half an inch in diameter; there was no areola around it, but one could see that the depth of the peripheral or vesicular part was reddish. The girl had three good primary vaccination marks. Having pricked the peripheral part of the vesicle, I obtained from it a capillary glass tube full of clear lymph slightly tinged with blood. Besides this lymph I took home with me crusts from sores of the cows' teats, which I was told were of about 10 days' standing.

Transmission of malady to calves.

On June 9th I inoculated one calf, No. 16, in 40 incisions with crusts of the cow, and another calf, No. 17, in 29 incisions with the lymph from the girl's vesicle.

Calf 16, as observation on the subsequent days proved, failed completely. But in the meantime Mr. Forty had sent me crusts from cow sores which were of not more than 8-10 days' standing. With some of these crusts I inoculated a fresh calf, No. 18, in over 40 incisions, and with very striking and positive results. Many insertions produced vesicles which in appearance and course were like vaccinia.

Calf No. 17 that was inoculated with the girl's lymph showed an equally striking and similar result. Drawings have been made of the eruption of this calf, and I describe the case in some detail, for the purpose of showing precisely what occurred in both calves.

My notes of calf No. 17 read as follows :—

4*th day* :—There are indications of redness about most of the incisions.

5*th day* :—The redness is much more marked and well defined; the insertions are somewhat swollen. The line of incision is occupied by a thin linear crust, around which is an indication of vesiculation.

6*th day* :—All insertions show distinct vesicles around central crusts; these latter are a good deal broader than yesterday. The redness is marked and well defined.

7*th day* :—Vesicles bigger, crusts broader.

8*th day* :—Further progress of vesicles [Fig. 15], redness still distinct, but less defined than previously. Clear lymph to be got from the vesicles.

9*th day* :—Some of the vesicles are yellowish, and seem to be getting covered with crusts. Purulent lymph in these vesicles.

10*th day* :—Most vesicles are covered by thick brown crusts [Fig. 16]; all are increased in breadth. The redness has gone down a good deal. Upon removing a crust a raw sore somewhat raised and covered with a purulent film is exposed; new crust is formed upon the sore by the next day. This condition, namely, the broadening of the brown crusts covering the insertions, without any areola, reached its height about the 12th to 14th day. By the 20*th day* many of the crusts had become partially loose, and crumbled easily away. The sores were dry. On the 24*th day* a few crusts only were left; the rest of the insertions appeared as dry slightly depressed whitish red cicatrices. *A few days later* all crusts had fallen off, leaving dry whitish depressed scars.

An accurate representation is given of the aspect of the incisions and their vesicles and crusts in Fig. 15 on the 8th, and in Fig. 16 on the 10th day.

Calf No. 16, which had failed after inoculation with crust from the Alderley cow, was again inoculated, in 35 incisions, with points

charged from 6th-day vesicles of the above calf, No. 17. And this time the great majority of the insertions went through exactly the same course and appearance as have been described of calf No. 17. In Figs. 17, 18, and 19, I give three accurate illustrations of the state of the insertions of calf No. 16, on the 6th, 8th, and 10th days; it is not necessary to further describe them.

its further transmission from calf to calf.

Two fresh calves, Nos. 20 and 21, were likewise inoculated, each in over 40 incisions, with points charged and crusts taken on 6th and 8th days, from vesicles of calf No. 17. [It ought to be stated that both calves 20 and 21, were at the time of inoculation affected extensively on head and neck with ringworm.] In both calves (Nos. 20 and 21), all insertions took splendidly; the first signs of success showing themselves, as before, on the 4th day by redness and slight swelling. The progress of the induced disease in calves Nos. 20 and 21 is accurately depicted in Figs. 20, 21, 22, and 23. These figures show the state of the insertions on the 4th, 5th, 6th, and 8th days. On the last-named day the breadth of some of the vesicles amounted to about one quarter of an inch. The crusts however which succeeded the vesicles were much larger; increasing in breadth and thickness until the 12th or 14th day. The appearances by the 10th day were precisely those described and illustrated in respect of previous calves [*see* Figs. 16 and 19]. On the 6th to 8th days, the lymph obtained from the vesicles was clear; on the 9th day, however, it had commenced to be purulent.

Several other calves were inoculated with points and crusts taken on the 6th to the 8th day from calves Nos. 16, 17, and 21. The result in these other calves was the same as in the previous calves, although not in all of them equally intensive, as regards the size of the vesicles and the breadth and thickness of the subsequent crusts.

In these Alderley calves (Nos. 16, 17, 20, and 21 for instance), after the crusts had all fallen off, whitish depressed linear scars about one-eighth of an inch in breadth remained visible for many weeks.

likeness of induced malady to Vaccinia.

As will be apparent from the preceding account of these inoculations, I was here dealing with a process which bears a considerable likeness to vaccinia. For a time however I doubted the identity of the two processes. The reasons for my doubts were chiefly that in the Alderley girl the vesicle contained clear lymph at a date more than 10 days subsequent to her accidental inoculation; moreover, there had been no areola around it. The girl too had three good primary vaccination marks, and the vesicle on her thumb instead of presenting the characters usual in a re-vaccination vesicle, had rather those of a somewhat retarded primary vesicle. Further the appearance and course of the vesicles in the calf seemed to me to be at least by one day retarded as compared with those we see at Lamb's Conduit Street, and similar retardation was maintained in several further removes from the original source.

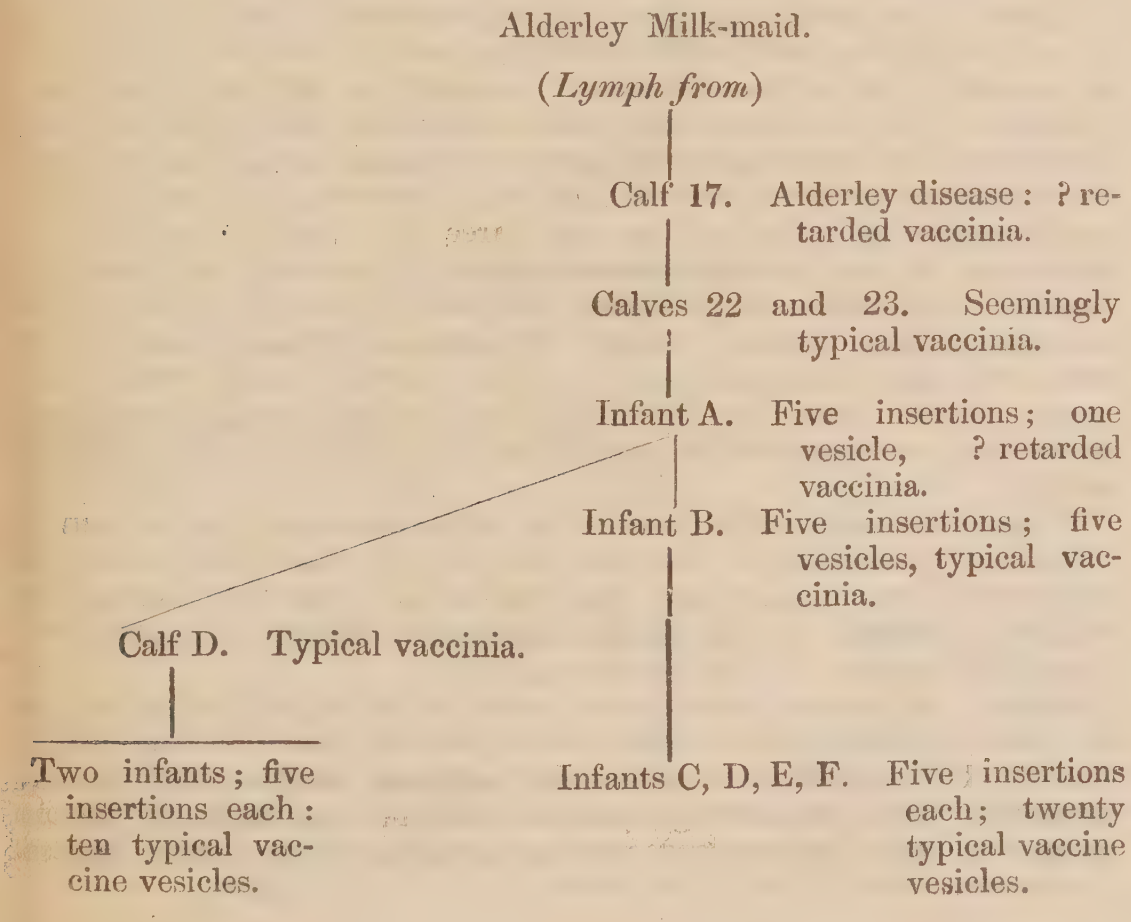
It seemed therefore important to test more accurately the relation of the above cow malady to vaccinia, and for this reason a number of observations and experiments were instituted, in the carrying out of which I obtained the aid of Dr. Cory, Mr. Shirley Murphy, and Mr. G. W. Collins.

Several preliminary experiments were made by inoculating calves at Lamb's Conduit Street, with crusts derived from Alderley calves Nos. 16, 17, 20, and 21; which crusts had been preserved for about a fortnight. The result though positive was not the same in amount as in the calves of previous experiments; the vesicles were not so

good, and the subsequent crusts not so big. The process was not, however, in any way accelerated; on the contrary it seemed as before retarded by about 24 hours.

I next inoculated, this time at the Brown Institution, two calves, Nos. 22 and 23, with crusts which had been taken on the 8th day from calf No. 17. These two calves, Nos. 22 and 23, took well; they had very fine and typical umbilicated vesicles on the 6th to the 8th days. With the lymph from calf No. 22, points were charged on the 8th day, on which occasion Dr. Cory, who saw calves Nos. 22 and 23, declared the appearances on them indistinguishable from vaccinia. Holding this view very strongly, Dr. Cory with one of the points from this source, inoculated by five insertions the arm of an infant (A.), which had never before been vaccinated. In this infant, on the 8th day, one insertion had taken; a small vesicle had appeared accompanied by but very slight areola. On the 9th day this vesicle was considerably enlarged, and the areola in connexion with it was pronounced (*see* illustration Fig. 24). On the 8th day Dr. Cory inoculated another infant (B.) from this vesicle of infant (A.) by five insertions; and on the 8th day following, all five insertions of infant (B.) were declared by Dr. Cory to be typical vaccinia (Fig. 25). From baby (B.) Dr. Cory vaccinated on the 8th day four additional infants (C., D., E., and F.), in five insertions each. All insertions in these four infants had by the 8th day developed into fine vesicles which Dr. Cory declared typical vaccinia.

Meanwhile from the vesicle of Baby A., I had inoculated on the 9th day calf D. All insertions in this calf (D.) took and developed into vesicles which on the 6th day could not be distinguished by Dr. Cory or by Mr. Collins from the vaccinia such as is habitually produced on the calves at Lamb's Conduit Street. With lymph taken from this calf (D.) Dr. Cory inoculated two infants in five insertions each; and on the 8th day Dr. Cory and Mr. Collins declared all ten insertions typical vaccinia. Thus far then we have the following pedigree :—



With a view to checking the above results, I, after the lapse of some weeks, inoculated two additional calves, Nos. 26 and 27, with a scab of the vesicle of the Alderley girl, sent kindly by Mr. Forty, and which had been removed by him from her thumb five days later than the lymph I collected from her vesicle. In each calf over 30 insertions were made.

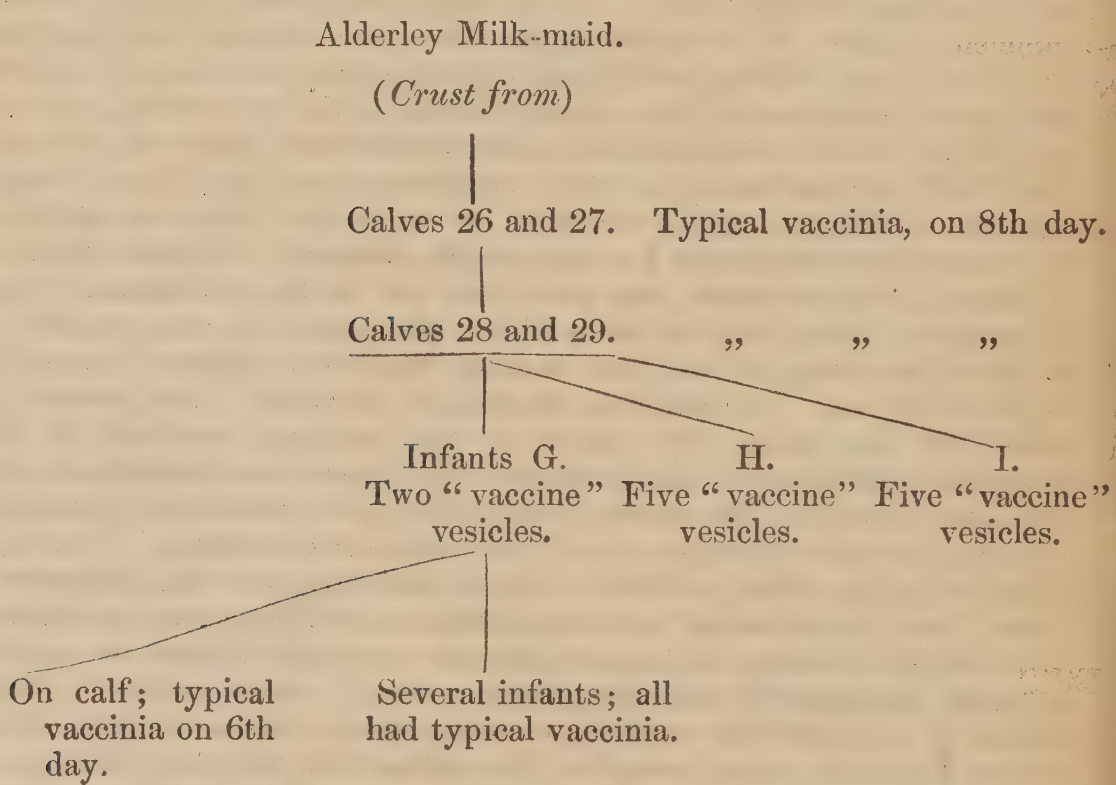
The result was the development in all insertions of vesicles which ran a course identical with that described in respect of calves Nos. 16, 17, 20, and 21.

With points charged on the 6th day from calf No. 26, and with scrapings taken from the vesicles of this calf on the 8th day, I inoculated two fresh calves, Nos. 28 and 29, each in over 50 insertions. The result was uniform and typical. All insertions developed as on previous calves into fine vesicles. The lymph taken from them on the 6th and 8th days was beautifully clear, and on both occasions I charged numerous points with it.

With points of 6th day lymph from this source Dr. Cory inoculated, in five insertions each, three infants, G., H., and I. On the 8th day G. had two small vesicles, H. and I. each five vesicles. As before these infants' vesicles closely resembled vaccinia. In the matter of areola those of infant H. were slightly advanced, those of G. and I. slightly retarded, as compared with ordinary 8th day vaccinations in infants.

With lymph taken from infant H. on the 8th day, I inoculated a calf in 13 insertions. All took, and on 6th day presented the appearance of typical vaccinia. Similarly, Dr. Cory vaccinated from infant H. other infants, in each of which all five insertions took and had developed by the 8th day into fine vesicles indistinguishable from vaccinia.

We have thus for this second series the following pedigree :—



After these additional experiments I was fully satisfied, so far as any conclusion could be drawn from the anatomical appearances and the course of the disease, as to the correctness of Dr. Cory's original contention, namely, that we were now dealing with vaccinia.

But in order to further test the action of lymph taken from calves successfully inoculated with the Alderley (Gloucestershire) disease, Dr. Cory, Mr. Murphy, Mr. Collins, and myself submitted ourselves to experiment therewith. But first we were all of us* "re-vaccinated" each in five insertions with 6th day lymph from one of the calves at Lamb's Conduit Street in use for the routine vaccination of infants there. Both Dr. Cory and Mr. Murphy failed to take, but one of my five insertions developed into a small vesicle with areola on the 8th day.

After the lapse of several weeks all four of us were inoculated, each in five insertions, with 8th day lymph from a calf in which Alderley (Gloucestershire) disease had been induced; but every one of the twenty insertions failed. At a later date, Dr. Cory, Mr. Collins, and myself were once more inoculated with 8th-day lymph of another calf of the Alderley (Gloucestershire) series; but again every one of the insertions failed.

Alderley calves "vaccinated."

As a final experiment several of the calves (Nos. 16, 17, 20, and 22), which had been successfully inoculated with the Alderley (Gloucestershire) disease, were subjected a few weeks after their Alderley eruption had quite died away and healed up, to vaccination with lymph from calves in use for routine vaccination at Lamb's Conduit Street. These four calves, Nos. 16, 17, 20, 22, had at this date fairly good depressed white cicatrices of their Alderley inoculation. Vaccination of them with Lamb's Conduit Street lymph failed completely.

The important question that now remained for final decision was: Are the maladies,—(1) of the Kingston cow, (2) of the Camberwell cow, and (3) of the Alderley (Gloucestershire) cow, in any way at all nearly related to each other? As to this I have already given, I think, sufficient reasons for considering the first two diseases (Kingston and Camberwell) as differing widely one from the other, not only as regards the course and nature of the original disease in the cow herself, but also in reference to the manifestations of the transmitted malady in the calf. But it will perhaps be argued that notwithstanding the different manifestations of the transmitted maladies in calves, they may nevertheless be one and the same; that for instance the different symptoms observed in calves of the two series may have been due to the circumstance that the material taken from the sores of the Kingston cow was obtained at a much later stage of the cow malady than that obtained from the Camberwell cow. In answer to objection of this sort, I am content to note that the course and aspect of the eruptions produced by the Kingston material on its first remove into calves was maintained with absolute fidelity in the calves of all subsequent removes, and that the like was, mutatis mutandis, true of the Camberwell material. This is, I think, tolerably strong evidence that in the Kingston and Camberwell cows I have been dealing with two definite and different types of disease. And that the disease was in each instance a specific disease is equally strongly indicated by the circumstance that in each series of calves attack by the particular malady protected against further attack. Thus in the Kingston series, several of the calves after they had completely recovered from the malady induced in them were subjected to a second inoculation, which altogether failed; and similarly, several of the

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* Except Mr. Collins, who had been recently re-vaccinated.

Camberwell calves were, after complete recovery, subjected to re-inoculation with the Camberwell disease, which likewise failed to take again on them.

Kingston calves inoculated with Camberwell material.

But in order to further test relations of the Camberwell and Kingston diseases, I selected the two calves, Nos. 6 and 7 of the Kingston series with a view of ascertaining whether they were susceptible of the Camberwell disease. I chose them, because they had shown such intense and very marked re-action to their primary inoculation, and had completely failed, when further tested by re-inoculation with the Kingston material, to take again that disease. It will be remembered that as a result of their primary inoculation with Kingston material, they had on the 4th day pronounced vesicles, on the 7th to 8th days thick crusts $\frac{1}{2}$–$\frac{3}{4}$ inch broad, which crusts did not fall off till towards the latter half of the third week.

These two calves, Nos. 6 and 7, three weeks after their second inoculation with Kingston material, and when all the marks of their induced Kingston disease had disappeared, were subjected to inoculation with crusts that had been derived on 8th day, and preserved, from Camberwell calf, No. 12. Over 30 insertions of Camberwell material were made into each calf, and with the following results:—*Every one of the insertions* of Camberwell material into these Kingston calves, Nos. 6 and 7, took in exactly the same way as in Camberwell calves, Nos. 12, 13, 14, and 15; the appearances were as striking, and in their course as typical, in the former as in the last-named calves.

In view of the fact that calves, Nos. 6 and 7, had suffered so severely from the Kingston disease, and had resisted re-inoculation with Kingston material, yet nevertheless proved fully susceptible later on of Camberwell disease, I was justified I thought in concluding that the Kingston and Camberwell diseases are distinct and separate maladies.

Kingston cow similarly inoculated.

But in order to put this to a final test, I determined to subject the Kingston cow herself, after all her scabs had fallen off,—*i.e.*, about the end of May, when all traces of her eruption had disappeared,—to inoculation with the Camberwell material. If this cow a week or two after complete recovery from the "spontaneously" acquired Kingston disease should, on inoculation with Camberwell material, prove susceptible to Camberwell disease, it must needs be admitted, I considered, that the Kingston and Camberwell maladies could not be one and the same disease. Be it remembered that this Kingston cow had obtained her Kingston disease *naturally*, and had suffered from it severely (*see* Figs. 1 and 2), so that in her case no question could arise (as perhaps might arise in the case of the experimental calves) as to her susceptibility to a new inoculation being due to attenuation, under subculture in experimental animals, of the infection material which had produced her original malady.

Accordingly on May 31st I inoculated the Kingston cow in numerous incisions on the udder and teats, with scrapings taken on the 7th day from Camberwell calf No. 13. Nothing occurred till the 4th day, when all 13 incisions were found tumid and surrounded by marked redness; the line of incision, which on the 2nd day had been observed to be occupied by a brown crust, was by this the 4th day much increased in breadth and thickness. This condition of swelling and redness was more prominent still on the 5th day. [I must ask the reader to inspect Figs. 26 and 27, particularly the former, and to note the swelling and redness, and especially the two accidental pimples, which of themselves suffice to prove the positive success of this inoculation.]

There was no vesiculation on this the 5th day, or on subsequent days, of the induced Camberwell sores in this Kingston cow. Nevertheless the crusts thickened, and became broader, on the 6th and 7th day, after which day the redness waned. Upon removing the thick firmly-adhering crusts on the 8th day slightly raised sores were exposed. By the 12th and 13th day the crusts had commenced to become loose.

The fact of this very positive result of the inoculation of this Kingston cow with the Camberwell material cannot be questioned, and it goes far to prove that the Kingston and Camberwell maladies are different diseases.

Camberwell calves inoculated with Alderley material.

In much the same way, the relations of the Alderley (Gloucestershire) and the Camberwell diseases, was tested by direct experiment.

Camberwell calves, Nos. 10, 12, 13, 14, and 15,—all of which had shown marked results after the primary inoculation with the Camberwell material (see Figs. 7–11 of calf 12, Figs. 13 and 14 of calf 15), were, after the marks of the Camberwell inoculations had quite disappeared, subjected to re-inoculation with crusts derived from and points charged with 7th and 8th-days' lymph of calves (Nos. 17 and 21) of the Alderley (Gloucestershire) series. The result was very striking.

All insertions of Alderley material in all these Camberwell calves took vigorously, the vesicles and crusts developing in a marked degree and exactly as in the original Alderley (Gloucestershire) calves. The progress of the eruption with the subsequent process of healing of the sores, and the falling off of the crusts, was in no way different from what has been described respecting the calves of the Alderley (Gloucestershire) series. In illustration of this I specially call the attention of the reader to Figs. 28–32.—Figs. 28 and 29 are two drawings made of the insertions in Camberwell calf, No. 12, on the 8th and 9th day respectively after inoculation with the Alderley (Gloucestershire) disease. Similarly, Figs. 30 and 31 are drawings of the insertions in Camberwell calf No. 15, on the 8th and 9th day respectively after inoculation with the Alderley (Gloucestershire) material. So again, Fig. 32 is a drawing of the appearances in calf No. 10 (the first of the Camberwell series), on the 8th day after the inoculation with the Alderley (Gloucestershire) material.

All this goes to show that the Camberwell and Alderley maladies cannot be one and the same disease.

Under the foregoing aspect, it will be convenient to record in this place the relations investigated during the early part of 1888 between vaccinia and the Wiltshire disease, treated of at length in my report of last year, and now seemingly identified with the Kingston disease above recorded. In my last report the diagnosis of the Wiltshire disease from cow-scarlatina was treated of at length, and any connexion between it and vaccinia was not then considered. A connexion of this latter sort was, however, presently affirmed; and for examination of this further question I made an experiment of the foregoing class. Vaccine lymph—the current stock of the Board's Animal Vaccine Establishment—was inoculated in its fresh state into calves which, on the authority of Professor Crookshank, had just passed through the Wiltshire disease.* Two of these calves took vaccine perfectly well, and in a normal manner, the third,† though it developed good vaccine

* The nature of the Wiltshire disease had been under debate. It was first brought forward by Professor Crookshank as an example of "typical vaccinia."

† This calf had been previously directly inoculated from the eruption of a milker who contracted it from a Wiltshire cow; the other two calves had been inoculated from the previous calf.

vesicles, had these slightly accelerated. The insusceptibility was therefore in no way extinguished by the previous eruption. One of these calves was shown to the Pathological Society on January 17th, 1888, and I find myself justified in concluding from the experiment that the disease brought from Wiltshire, and alleged to have been produced by Professor Crookshank, was proved not to be really vaccinia; for we know that vaccine lymph will not "take" a second time on a calf that has previously been successfully vaccinated, provided the second operation has been done (as in this instance) a month after the result of the first vaccination has passed off.*

---

* Note in this connexion the observations on page 387. Professor Crookshank (B.M.J., July 7th, 1888) advances the following consideration by way of afterthought:—That the Wiltshire disease ought not to be denied the title of true vaccinia on the ground that the calf which had passed through this disease could be effectually vaccinated at the Board's Animal Vaccine Establishment.—I understand him to support his contention by the argument that the calf had been inoculated with material taken from a human subject, and had not received an ample dose of such material in the first instance; whereas at Lamb's Conduit Street, the subsequent operation was very thoroughly done and with lymph direct from a bovine source. I cannot say that I attach much importance to these considerations.



M.H.Lapidge del.

Fredk Dangerfield Lithographer, London 16065

KINGSTON COW DISEASE.

FIG. I.

Sores and scabs on the teats of the Kingston cow, three to four weeks after commencement of her malady.

KINGSTON COW DISEASE.

FIG. II.

Sores and scabs on teats of Kingston cow, three to four weeks after commencement of her malady.



M. H. Lapidge del.

Fred.k Banfield, Lithographer, London. 16065



M.H.Lapidge del.

Fred^k Dangerfield, Lithographer, London 16065

KINGSTON COW DISEASE.

FIG. III.

Appearance of abdomen of Kingston Calf No. 2 on the *third day* after inoculation with material from the ulcers of the Kingston cow.

KINGSTON COW DISEASE.

FIG. IV.

Appearance of abdomen of Kingston Calf No. 2 on the *fourth day* after inoculation with material from the ulcers of the Kingston cow.

[The calendar day next succeeding an operation is here spoken of (as in the text of the report, see page 375) as "the second day after," and so forth.]



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Fred^k Dansfield. Lithographer, London 16065

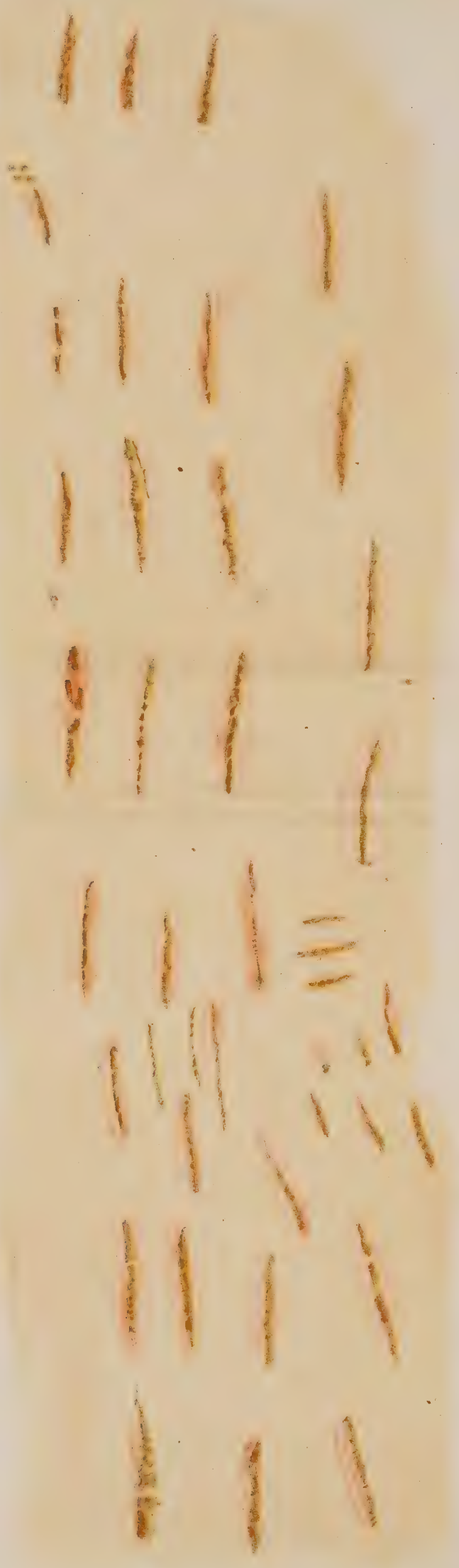
CAMBERWELL COW DISEASE.

FIG. VI.

Appearance of abdomen of Camberwell Calf No. 10 on the *sixth day* after inoculation with crusts and material from an ulcer on the Camberwell cow.



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M.H. Lapidge del

Fredk Bennett lithographer London 1838

CAMBERWELL COW DISEASE.

Fig. VII.

Appearance of abdomen of Camberwell Calf No. 12 on the *fifth day* after inoculation with scabs and scrapings from induced sores on Camberwell Calf No. 10.

CAMBERWELL COW DISEASE.

Fig. VIII.

Appearance of abdomen of Camberwell Calf No. 12 on the *sixth day* after inoculation.



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CAMBERWELL COW DISEASE.

FIG. IX.

Appearance of abdomen of Camberwell Calf No. 12 on the *seventh day* after inoculation.

CAMBERWELL COW DISEASE.

FIG. X.

Apparance of abdomen of Camberwell Calf No. 12 on the *eighth day* after inoculation.



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CAMBERWELL COW DISEASE.

FIG. XI.

Appearance of abdomen of Camberwell Calf No. 12 on the *eleventh day* after inoculation.

CAMBERWELL COW DISEASE.

FIG. XII.

Appearance of abdomen of Camberwell Calf No. 14 on the *sixth day* after inoculation with crusts and scrapings from induced sores on Calves Nos. 12 and 13, Camberwell series.



FIG. XII.

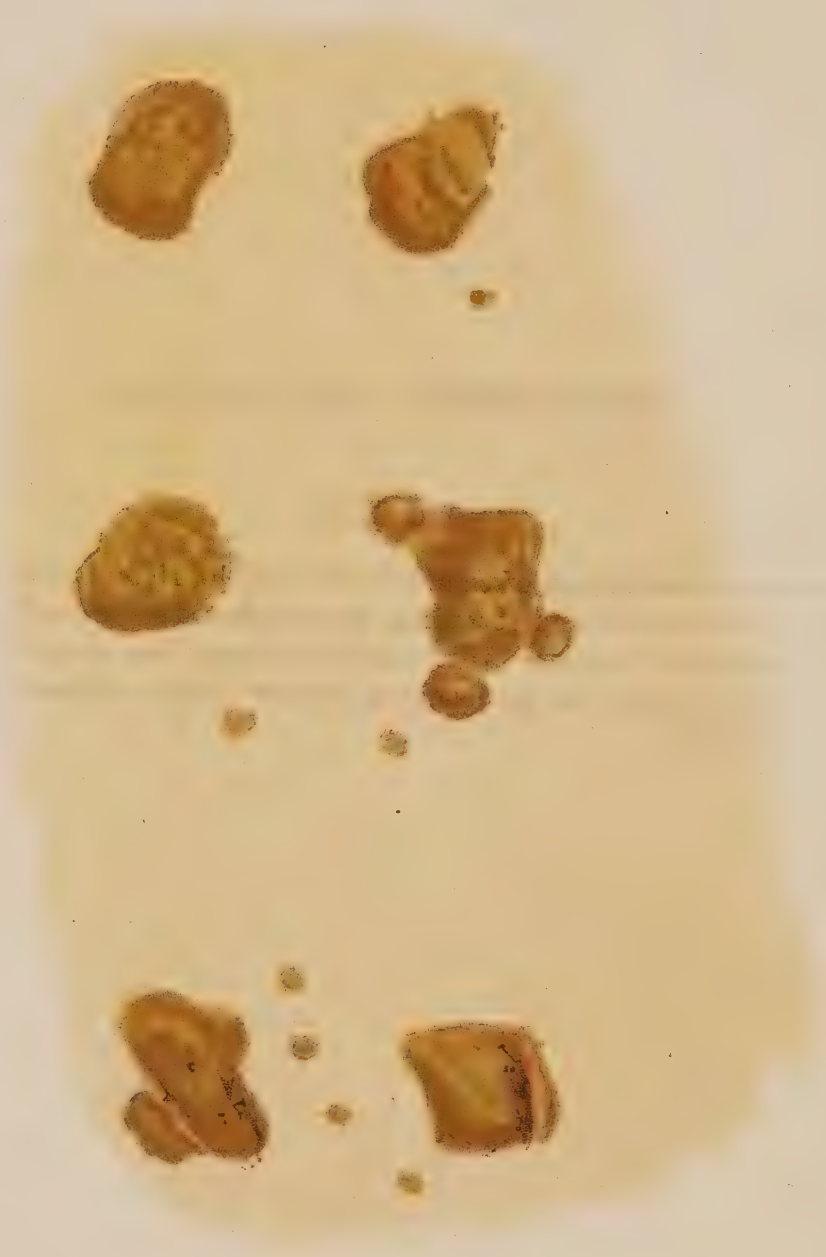


FIG. XIII.

M.H.Lapidge.del. Dangerfield, Lithographer, London. 1872

CAMBERWELL COW DISEASE.

Fig. XIII.

Appearance of abdomen of Camberwell Calf No. 15 on the *tenth day* after inoculation with crusts and scrapings from induced sores on Calves Nos. 12 and 13, Camberwell series. Interspersed among the crust-covered sores of this Calf No. 15 are to be observed several minor accessory sores, also covered with crusts.

CAMBERWELL COW DISEASE.

Fig. XIV.

Appearance on the tenth day of the induced sores on abdomen of Camberwell Calf No. 15 (see Fig. XIII.) after removal of the crusts.



FIG. XIV.



FIG. XV.

ALDERLEY COW DISEASE.

FIG. XV.

Appearance of abdomen of Alderley Calf No. 17 on the *eighth day* after inoculation with lymph from the Alderley milk-maid's vesicle.

ALDERLEY COW DISEASE.

Fig. XVI.

Appearance of abdomen of Alderley Calf No. 17 on the *tenth day* after inoculation with lymph from the Alderley milk-maid.



FIG XVI.

H. Lapidge del. Dangerfield, Lithographer, London. 1873.



FIG XVII.

ALDERLEY COW DISEASE.

Fig. XVII.

Appearance of abdomen of Alderley Calf No. 16 on the *sixth day* after inoculation with lymph from the Alderley milk-maid.

ALDERLEY COW DISEASE.

Fig. XVIII.

Appearance of abdomen of Alderley Calf No. 16 on the *eighth day* after inoculation with lymph from the Alderley milk-maid.



FIG. XVIII.

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FIG. XIX.

M.H. Lapidge, del. Dangerfield, Lithographer, London. 1873.

ALDERLEY COW DISEASE.

Fig. XIX.

Appearance of abdomen of Alderley Calf No. 16 on the *tenth day* after inoculation with lymph from the Alderley milk-maid.

ALDERLEY COW DISEASE.

Fig. XX.

Appearance of abdomen of Alderley Calf No. 21 on the *fourth day* after inoculation with crusts and matter on points obtained from Calf No. 17, Alderley series.



FIG. XX.



FIG. XXI.

M. H. Lapidge, del. Dangerfield, Lithographer, London. 1873

ALDERLEY COW DISEASE.

Fig. XXI.

Appearance of abdomen of Alderley Calf No. 21 on the *fifth day* after inoculation with material from Calf No. 17, Alderley series.

ALDERLEY COW DISEASE.

Fig. XXII.

Appearance of abdomen of Alderley Calf No. 21 on the *sixth day* after inoculation with material from Calf No. 17, Alderley series.

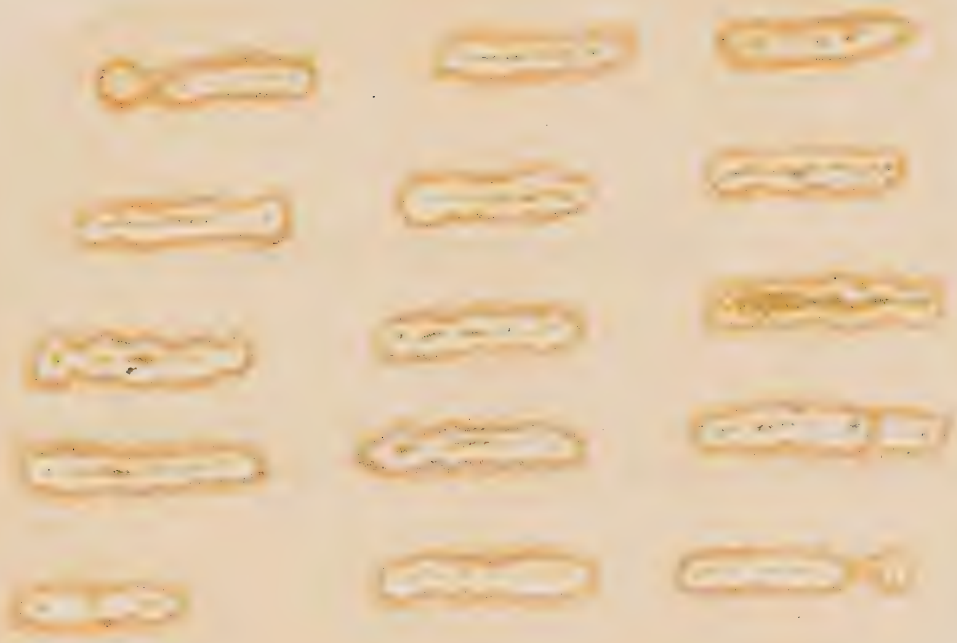


FIG. XXII.



FIG. XXIII.

ALDERLEY COW DISEASE.

Fig. XXIII.

Appearance of abdomen of Alderley Calf No. 21 on the *eighth day* after inoculation with material from Calf No. 17, Alderley series.

ALDERLEY COW DISEASE.

Fig. XXIV.

Appearance of arm of infant A. on the *ninth day* after inoculation with lymph taken on the *eighth day* from Calf No. 22 of the Alderley series.



FIG. XXIV.

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Dan.erfield Lithographer, London 1873.4



FIG. XXV.

M. H. Lapidge, del. Dangerfield, Lithographer, London. 1874

ALDERLEY COW DISEASE.

FIG. XXV.

Appearance of arm of infant B. on the *eighth day* after arm-to-arm vaccination from infant A.

CAMBERWELL COW DISEASE.

Fig. XXVI.

Appearance of a portion of udder of *Kingston Cow* on the *fifth day* after inoculation of material from *Camberwell Calf* No. 13.



FIG. XXVI.

H. Lepage, del. Dangerfield, Lithographer, London. 1873.4



FIG. XXVII.

M.H Lapidge, del.

Dangerfield Lithographer London 1874

CAMBERWELL COW DISEASE.

Fig. XXVII.

Appearance of teats of *Kingston Cow* on the *fifth day* after inoculation with material from *Camberwell Calf* No. 13.

ALDERLEY COW DISEASE.

Fig. XXVIII.

Appearance of abdomen of *Camberwell Calf* No. 12 on the *eighth day* after inoculation with lymph from a calf of the *Alderley* series.



FIG. XXVIII.

Lapidge, del. Dangerfield, Lithographer, London. 18735



FIG. XXIX.

M.H.Lapidge, del. Dandertield Lithographer London 1873

ALDERLEY COW DISEASE.

Fig. XXIX.

Appearance of abdomen of *Camberwell Calf* No. 12 on the *ninth day* after inoculation with lymph from a calf of the *Alderley* series.

ALDERLEY COW DISEASE.

Fig. XXX.

Appearance of abdomen of *Camberwell Calf* No. 15 on the *eighth day* after inoculation with material from a calf of the *Alderley* series.



FIG. XXX.

Lapidge, del. Dangerfield, Lithographer, London 18735.



FIG. XXXI.

M. H. Lapidge, del. Danperfield. Lithographer, London. 18735

ALDERLEY COW DISEASE.

Fig. XXXI.

Appearance of abdomen of *Camberwell Calf* No. 15 on the *ninth day* after inoculation with material from a calf of the *Alderley* series.

ALDERLEY COW DISEASE.

Fig. XXXII.

Appearance of the abdomen of *Camberwell Calf* No. 10 on the *eighth day* after inoculation with material from a calf of the *Alderley* series.

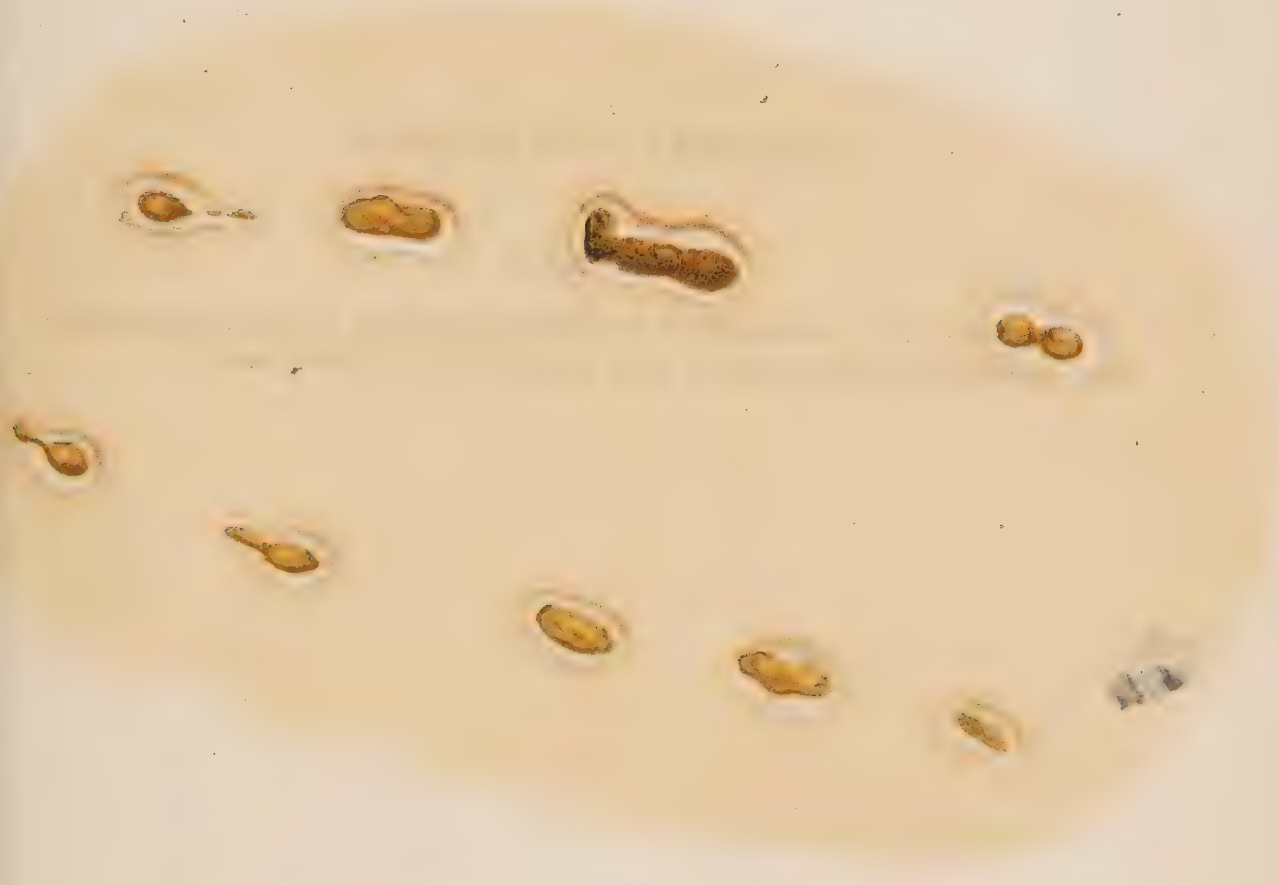


FIG. XXXII.



M.H.Lapidge del.

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VACCINIA.

Fig. XXXIII.

Appearance of abdomen and scrotum of a "Wiltshire" calf on the *sixth day* after calf-to-calf vaccination (in January 1888) with the lymph current at Lamb's Conduit Street Animal Vaccine Station. [It was this calf which was exhibited by Professor Crookshank to the Pathological Society on 15th December 1887, as illustrating in the calf the induced Wiltshire disease.]

VACCINIA.

Fig. XXXIV.

Appearance of abdomen of a second "Wiltshire" calf on the *fifth day* after calf-to-calf vaccination with the lymph current at the Lamb's Conduit Street Animal Vaccine Station.



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No. 2.

II. On the Etiology of Diphtheria; by Dr. Klein, F.R.S.

A large number of statements have from time to time been made as to the presence in diphtheria of various species of microbes, and as to the etiological relations of one and another of them to that disease.* But not until Klebs (Schweizer Correspondenzblatt, 1883), and particularly Löffler (Mittheilungen aus d. k. Gesundheitsamte, Bd. II., 1884), gave attention to the matter, was any real and trustworthy progress made toward knowledge of a bacterial cause of this dire malady. Klebs was the first to point out that in diphtheritic membranes, which commonly contain abundance and great variety of microbes, there is uniformly present a bacillus possessing definite morphological characters by which it can be identified, and which is, in his experience, peculiar to diphtheria. Löffler, while confirming the frequent presence in diphtheria of this species of bacillus, succeeded also in isolating it by artificial cultivation, and in carrying out with sub-cultures of the micro-organism thus isolated an important series of experiments. He succeeded too in showing that this bacillus, along with crowds of other bacteria, is present only in the superficial layers of the diphtheritic membrane; that it is absent from the deeper layers of this membrane and from the tissue of the mucous membrane of the throat, as well as from all internal organs. Further Löffler showed that in some cases of diphtheria, certain other bacteria (notably a streptococcus) may be occasionally found present *in the depth of* the mucous membrane of the throat. In nine only out of 22 cases did he find the particular bacilli, in sections through the affected throat, within the diphtheritic membranes; in the other 13 they were absent, though other bacteria were often present, and amongst them streptococci, extending into the depth of the tissue of the mucous membrane. And, be it observed, Löffler has not claimed discovery of the microbe of diphtheria: on this matter he has always expressed himself with caution and reserve.

Klebs-Löffler bacillus:

Before proceeding further, I give briefly the characters recorded of the Klebs-Löffler bacillus, supplementing this account later on from my own observations.

its morphology:

According to Klebs and Löffler, the bacilli in question are non-mobile rods slightly curved, about the same length as, though twice the thickness of, tubercle-bacilli. Beside their frequently observed curved condition, many possess a characteristic terminal enlargement, which gives them, if the enlargement involves one end only, a slightly pear-shaped appearance; if both ends be involved, their appearance is more or less dumb-bell shaped. In the latter case the enlargements of the ends are usually unequal, but there is always an appreciable rod-shaped bridge between them; the ends are always rounded. Occasionally the rods seem made up of large granules. These bacilli do not grow at temperatures below 22° C., and do not therefore flourish in nutrient gelatine kept, as is ordinarily the case with this medium, at about 20° C. They grow well, however, on serum at 37° C., on Agar beef broth (Flügge) at 35° C. and higher, and in beef broth 35–37° C. On serum, on Agar mixture, and in broth they grow rapidly; on the former media the

and cultural characters.

* In reference to the earlier literature of this subject, the contributions of Oertel and of Von Emmerich are perhaps the most important.

colonies grow as whitish, moist-looking, flat droplets, their outlines rounded, but in some soon becoming slightly irregular. In streak cultures on solid serum or on Agar mixture the line of inoculation is marked even after one day as a whitish streak, made up of a number of whitish droplets, which gradually enlarge and become confluent, their outline remaining irregularly knobbed. On potato the bacilli do not show growth.

"Pseudo-diphtheria-bacillus:"

Now a very important observation was early made by Löffler:—he found this identical species of bacillus in the fluid of the mouth of a perfectly healthy child. And another important discovery was made by v. Hoffmann (Wiener Med. Woch., 1888, N. 3 and 4), who found a bacillus, identical in morphological and cultural characters with the Klebs-Löffler bacillus, constantly present in the mucus of the human pharynx. True, Löffler (Centralblatt f. Bacteriologie and Parastenk. II., 1887) had previously stated that besides the Klebs-Löffler bacillus there occurs in the diphtheritic membranes a species of bacillus which resembles it in many respects, both microscopically and culturally, and which he, Löffler, called pseudo-diphtheria-bacillus. Von Hoffmann, it is true, thought that the bacillus which he himself found constantly in the pharyngeal mucus of healthy children, must be this pseudo-diphtheria-bacillus; and he stated that the two are different one from another in this, namely, that while the Klebs-Löffler bacillus is virulent for certain rodents, the pseudo-diphtheria-bacillus is non-pathogenic for rodents of the same species. This view, however, has been almost universally abandoned (see Baumgarten: Lehrbuch d. patholog. Mycologie II. i., p. 694). It is now regarded as proved by v. Hoffmann's own researches, and by Flügge and others, that on the one hand there exist no microscopic and cultural differences between the Klebs-Löffler bacillus and the pseudo-diphtheria-bacillus, and that on the other hand the alleged pathogenic power of the former is inconstant, as is also the non-pathogenic power of the latter.

its identity with that of Klebs and Löffler:

The matter then stands thus:—the Klebs-Löffler bacillus is present in most cases of diphtheria but generally only in the superficial layers of the diphtheritic membrane; and also it is present in the pharyngeal mucus of many healthy children. This fact alone goes far, I think, to disprove any etiological connexion between the Klebs-Löffler bacillus and the diphtheritic process. The histological examination of all healthy fauces, young and adult, shows that in the mucous membrane at the back of the tongue, on the palatine tonsil, and on the upper part of the pharynx (the pharyngeal tonsil), the mucous membrane of the superficial layers contains lymphatic tissue either as closely aggregated lymph-follicles or as diffuse lymphatic tissue; and that this tissue is in constant manner pervading, penetrating, and growing through the most superficial layer of the mucous membrane, including the stratified epithelium of the free surface. As a matter of fact a fine section through any of these organs shows the superficial epithelium invaded and flooded by the lymph-cells of the lymphatic tissue; the so-called mucus cells present in the fluid of the mouth and fauces are indeed lymph-cells which have penetrated through the epithelium. These conditions obtaining under all normal and becoming intensified under abnormal circumstances, say catarrhal conditions, it follows that the surface of the mucous membrane is not truly intact over those parts, *i.e.*, back of the tongue, tonsils, and upper part of pharynx. Now it might be argued, and as a matter of fact has been and is argued, that though the (diphtheritic) bacillus of Klebs-Löffler may be present in the throat that is in a normal condition, it need not produce diphtheria there so long as the mucous membrane of the throat be intact. But, it is contended,

? either true cause of diphtheria.

let there be an abrasion of the surface epithelium whereby the tissue of the mucous membrane becomes exposed,—then the bacilli will be able to get to the membrane proper and in so doing will obtain opportunity to set up diphtheria. This indeed is in substance the argument used by Roux and Yersin in their paper on diphtheria to be presently referred to in other connexion. The argument, however, is quite inadmissible, since, as I have pointed out, the mucous membrane at the back of the tongue, over the tonsils, and in the upper part of the pharynx, is never intact in the sense that we find it in other parts of the cavity of the mouth and pharynx. A microscopic section through any of those parts shows this conclusively. There is plenty of opportunity under normal conditions, at the back of the tongue, on the tonsils, and on upper part of the pharynx for the bacilli to enter, through breaches of the partially disorganised epithelium, the superficial layer of the mucosa propria. The above argument of Roux and Yersin is then on histological grounds quite inadmissible.

Löffler's experiments with his bacillus.

A large number of experiments were performed by Löffler with the Klebs-Löffler bacillus on rabbits, fowls, pigeons, mice, and guinea-pigs; the last-named animals being found most susceptible to the action of this bacillus. His account of his proceedings is as follows:—By injecting cultures of the bacillus into the subcutaneous tissue of this animal an extensive hæmorrhagic œdematous swelling is produced at the seat of inoculation, and the animal dies often on the second to the third day. On *post-mortem* examination the nearest lymph glands are infiltrated and contain hæmorrhages; the lungs are found inflamed, and the pleural cavity contains sanguineous exudation. If cultures are, after tracheotomy, introduced into the trachea of rabbits, pigeons, fowls; or if they are rubbed into the scraped mucous membrane of the conjunctiva of rabbits, or vagina of guinea-pigs; a sort of pseudo-membranous exudation is formed on the surface, and commonly a general fatal infection of the system occurs. In certain of his experimental animals, a kind of paralysis of the limbs followed, he says, upon the induced infection. But neither in the blood of the dead animals, nor as a rule in the pseudo-membranes, were the bacilli to be found. From these experiments the conclusion that the Klebs-Löffler bacillus acts pathogenically on these animals is no doubt justified; but it is not justifiable to assume that this micro-organism is the cause of diphtheria, nor indeed that the above induced processes are analogous to diphtheria. For in the first place, it is a very well-established fact that a good many species of bacteria occurring in healthy secretions and products of the human body are, though absolutely harmless to man, very virulent to rodents, producing in these animals local hæmorrhages followed by general fatal infection. To mention only a few examples:—the capsulated micrococcus (or bacillus) in the normal fluid of the mouth, a bacillus found by Bienstok as a normal inhabitant of the colon (bacillus coli communis), the bacillus in fæces discovered by Brieger, the comma-bacillus of Finkler, and various other microbes. And in the second place, pseudo-membranous exudations on the surface of mucous membranes (of the trachea especially) previously purposely scraped and injured, have been noticed under various conditions to follow the application of mere chemical agencies, not to speak of application of various species of bacteria capable of producing an infection. On this point I may mention Penzoldz's most instructive paper (Deutsches Archiv f. Klin. Med. 42, 1887) and also Prof. Baumgarten's very elaborate analysis (*l.c.*, pp. 706, 707).

Having regard to all these facts, especially the limitation of the Klebs-Löffler bacillus to the superficial parts of diphtheritic membranes, to

its presence in the normal human fauces, and to the pathogenic action on animals of this bacillus not being essentially diphtheritic, it is no matter for surprise that the view that this bacillus is the cause of diphtheria has come to be discredited by many pathologists and bacteriologists.

Experiments by Roux and Yersin.

Within the last year, however, MM. Roux and Yersin have given an account (published at the commencement of 1889) of their work in the Annals of the Pasteur Institute (1888, N. 12), which, strange to say, starts with the assumption that the Klebs-Löffler bacillus is really the cause of diphtheria. These observers go over almost the same ground as did Löffler, making the same kinds of experiments and with much the same results ; but they did not enter with the same minuteness into the distribution in diphtheria of the Klebs-Löffler bacillus, and they did not pay the necessary amount of attention to the presence of these bacilli in the normal fauces, nor did they exercise, so far as I can discover, some needful caution, before accepting as valid the results of their own experiments. A considerable part of their paper is, however, given to an account of important series of experiments made with nutritive fluid (broth) after it had served for the growth of the Klebs-Löffler bacillus, and after the latter had been removed from it. This fluid was injected into the subcutaneous tissue of experimental animals, and when used in sufficient quantity (the required quantity depending on the age of the culture) produced either a rapidly fatal result or a less acute illness with subsequent paralytic symptoms. As regarded inoculation of the actual bacilli of their cultures, if the animals (pigeons and rabbits) survived the acute stage of the malady thereby induced (that of so-called pseudo-membranes), they showed, as did some of Löffler's, later (after three weeks) paralytic symptoms.

It is not a little odd that MM. Roux and Yersin did not first ascertain the effect on experimental animals of inoculation into them of the diphtheritic membrane of the human subject, before proceeding to inoculation of cultures of the Klebs-Löffler bacillus. Instead they assumed at the outset as proved, that which to many pathologists and bacteriologists is very far from proved. And my own observations which I proceed now to describe will show how important such experiments with diphtheritic membranes are, and how different their results from those obtained with cultures of the Klebs-Löffler bacillus.

I. *Experiments with Human Diphtheritic Membranes.*

New Experiment: Diphtheria membranes inoculated into animals.

(*a.*) From a marked case of diphtheria,—a boy æt. five who had been ill of the disease for eight days,—discharge of pharynx and mouth was obtained, and this I inoculated into the purposely abraded mucous membrane of the pharynx and larynx of two fowls and of two pigeons. The animals remained well ; no change of any kind was to be noticed in their pharyngeal or laryngeal mucous membrane at the end of two days or later.

(*b.*) Two guinea-pigs were inoculated subcutaneously into the groin with the same material. After two days a firm nodular swelling could be felt in the subcutaneous tissue at the seat of inoculation, but this tumour gradually became smaller, and by the end of a fortnight had quite disappeared.

(*c.*) Two rabbits were inoculated on the purposely abraded mucous membrane of the palate, tongue, and pharynx, with the same diphtheria material. After two to three days, nothing could be seen on the mucous membrane, and the animals remained perfectly well.

(*d.*) With diphtheritic membrane of an acute case,—a girl æt. seven years, showing very typical membranes on tonsils and fauces,—I inoculated subcutaneously four guinea-pigs. Pieces of the diphtheritic membrane were cut up finely and suspended in sterile salt solution, and of this mixture about half a Pravaz syringeful was injected into the subcutaneous tissue of the groin. On the second day a swelling was noticed in each instance in the region of the inoculation; this enlarged gradually until the fifth day, by which time it had spread for some distance from the groin.

One guinea-pig was found dead on the sixth day; a second was at this date very shaky and could only move with difficulty; the other two guinea-pigs showed great swelling in groin and were very quiet.

On post-mortem examination of the dead guinea-pig, there was found considerable œdematous swelling in the subcutaneous tissue of the groin extending upwards over the greater part of the abdomen and chest; and there was present at the same time in the subcutaneous tissue of the groin much congestion. The suprarenals were deeply congested, of almost dark purple colour; the spleen dark, and slightly enlarged; the kidneys, the liver, and the lungs, very much congested. The organs of the throat showed no noticeable change. Cultivations were made of the heart's blood, of the lung juice, and of the œdematous fluid of the subcutaneous tissue of this guinea-pig; at the same time these fluids were examined microscopically as dried and stained cover-glass specimens. Microscopic examination showed the absence of bacteria of any kind from the heart's blood and lung juice, and the fact of their absence was confirmed by the culture test. In the œdematous fluid of the subcutaneous tissue, however, there were present in the cover-glass specimens micrococci as diplococci and short chains; but they were not numerous. Of other bacteria, *e.g.*, Löffler's bacillus, there was nothing to be seen. In culture tubes inoculated with this œdematous fluid the same micrococci were obtained. They form on gelatine white, pearly, moist-looking droplets, which, after about six days, begin to slowly liquefy the gelatine.

The second guinea-pig died towards the end of the sixth day. On post-mortem examination it showed exactly the same appearances as the first guinea-pig; the same conspicuous œdematous swelling in the groin and over abdomen and chest; the same extreme congestion of the internal viscera; the same micrococci in the fluid of the subcutaneous œdema and in cultures therefrom; the Löffler bacillus not being detectable either in microscopic specimens or in the cultures.

A third guinea-pig was found very quiet and shaky on the seventh day; it died in the course of the day. Here again examination showed identical conditions of the viscera, and absence of Löffler's bacillus in the fluid and tissue of the subcutaneous tumour, as also absence of all bacteria from the heart's blood, lung juice, and spleen tissue.

The fourth guinea-pig was on this day (seventh day) very quiet, and had considerable swelling in the groin at the seat of inoculation.

On the eighth day it was found livelier, though it had still much swelling in the groin.

On the 10th day it was again found to be quiet, and it died on the night of the 11th day. Post-mortem: there was little œdema in this animal, but a firm purulent tumour at the seat of inoculation; the viscera were in the same state as in the previous animals. But once more no Löffler's bacillus could be found in and about the tumour, or in any other tissue, either by microscopic examination of specimens or by cultivation. From the tumour itself, only micrococci could be obtained.

These results can scarcely be considered as indicating an induced diphtheritic process, rather they are consistent with a general septic intoxication due to the original tumour. And it is noteworthy that, while the diphtheritic membrane from the human subjects used for these inoculations contained the Klebs-Löffler bacillus (as was proved by microscopic examination), no trace of this organism could be found in the tissue of the swellings in the groins of the experimental guinea-pigs examined on the 6th, 7th, and 12th days. Nor could these bacilli or any other bacteria be found in the blood or the other tissues. This coincides with the observations of MM. Roux and Yersin, who found that, after subcutaneous inoculation of guinea-pigs with Klebs-Löffler bacillus, the number of these organisms to be obtained at the seat of inoculation diminished rapidly from hour to hour.

(*e.*) From a well-marked case of diphtheria,—a boy, æt. three, who died before the end of six days with well-marked diphtheritic membranes in all parts of the fauces,—diphtheritic membrane mixed with salt solution was injected subcutaneously into the groins of two guinea-pigs. After two days a small firm swelling was noticed in each guinea-pig at the seat of inoculation. In both the nodule enlarged considerably during the following day, and opened spontaneously on the ninth day, with the result that a slightly depressed ulcer was established, which by the 12th day extended from the site of inoculation over the upper part of the inside of the thigh, and the hypochondrium. The base of the ulceration was infiltrated, looked dark, and was covered here and there with purulent matter. The animals were quiet.

One of them was killed on this the 12th day. Post-mortem, the muscular tissue of the abdomen at the site of the ulcer was found much infiltrated with purulent matter, as was the muscular tissue of the chest wall of the same side. There was no change in the organs of the throat or in any of the viscera. Cover-glass specimens and cultivations were made from the infiltrated purulent muscular tissue, but no trace of the Klebs-Löffler bacillus could be detected; only micrococci were present. No bacteria were obtainable by culture from the internal organs.

The second guinea-pig died on the 20th day, from accidental infection with pneumonia. At this date the ulceration had greatly diminished and was advanced towards healing.

(*f.*) With diphtheritic membrane of a typical case of diphtheria,—a girl, æt. 11, dead on the ninth day with a very bad diphtheritic throat,—I inoculated in the purposely abraded mucous membrane of the larynx and pharynx two fowls and two pigeons. These fowls and pigeons showed no symptoms of disease.

(*g.*) Two guinea-pigs were inoculated subcutaneously in the groin with diphtheritic membrane from a typical acute case of diphtheria. Both had swelling there on the third day; one died on the fifth day. On post-mortem examination, a thickening of the subcutaneous tissue was found at the seat of inoculation; it was slightly œdematous and infiltrated with purulent matter. Both lungs were hyperæmic; the spleen small, its tissue containing numerous miliary abscesses from the size of the point of a pin to that of a pea; kidneys much congested. The fatal result points strongly to pyæmic infection.

The other guinea-pig, though it had a firm swelling at the seat of inoculation, was at this date nevertheless otherwise lively and well; and it remained so, the tumour meanwhile slowly but gradually diminishing. On the 21st day the animal had a small abscess in the groin, but was otherwise lively and well.

(*h*.) Two guinea-pigs were inoculated on the purposely abraded mucous membrane of the fauces with the same diphtheritic membranes as the above two animals (*g*). No result.

Summary of results of inoculation of diphtheria membranes.

From these experiments it would appear then: (1) that pigeons, fowls, and rabbits inoculated with typical diphtheritia membrane into the mucous membrane of the fauces and larynx previously purposely abraded, show no reaction; and (2) that guinea-pigs inoculated subcutaneously in the groin with typical diphtheritia membrane, do show a reaction, a tumour with œdema being found at the seat of inoculation, which in some cases led to the death of the animals under appearances indistinguishable from septic intoxication, while in others the tumour at the seat of inoculation was succeeded by an extensive ulceration with severe purulent infiltration of the neighbouring muscular tissue.

In all these cases micrococci alone were discoverable about the seat of inoculation, and neither the Klebs-Löffler bacillus nor any other organisms were discoverable in the internal organs. Accordingly I do not see any reason for regarding this reaction as of the nature of diphtheria.

Further, these results of mine in no way support the contention (as, for instance, of Löffler, Roux and Yersin) that diphtheria is transmissible to the mucous membrane of the fauces of rabbits, fowls, and pigeons. In the experiments which I made the diphtheritic membranes used for inoculation were derived from cases under the care of Dr. Sweeting, at the Fulham Fever Hospital, and in each instance the affection of the throat in the human subject was declared by Dr. Sweeting to be severe and unequivocal diphtheria; the diphtheritic membranes used for inoculation were applied freely, in fact large flakes were introduced; the mucous membranes of the pharynx and the entrance of the larynx were well scraped and the diphtheritic flakes well rubbed over the abraded surface and left there; and yet no positive result followed.

I think from this that I am justified in questioning the transmissibility of human diphtheria to rabbits, fowls, and pigeons. The Klebs-Löffler bacillus, with which Löffler, as well as Roux and Yersin, carried out experiments on these several species of animals, and by the application of which to the scraped mucous membrane of the fauces it has been maintained that (diphtheritic) pseudo-membranes have been produced, was indeed derived from the diphtheritic membranes of human cases; but it seems to me questionable whether the positive pathogenic results obtained by those observers in these as well as in other animals (guinea-pigs), after subcutaneous inoculation of the Klebs-Löffler bacillus, can be put down as indicative of diphtheria. As to the pathogenic results that I myself obtained by subcutaneous inoculation of guinea-pigs, I think it would be unjustifiable to consider them as indicating diphtheria.

II. *Observations of the Klebs-Löffler Bacillus.*

Further observation of Klebs-Löffler bacillus:

From several cases of diphtheria dead during the acute stage of the disease, and with characteristic membranes in the fauces, I have isolated by cultivation the Klebs-Löffler bacillus. In one case only did I obtain it from a swollen and congested cervical lymph-gland. Out of four diphtheria membranes (three taken from the fauces of patients after death and one during life) I have succeeded in isolating by cultivation the Klebs-Löffler bacillus in three only; and along with it, of course, I also isolated other bacteria. In all cases of success, an ordinary broth Agar-

mixture was used as the culture medium. In the case of the cervical lymphatic gland one other species was obtained besides the Klebs-Löffler bacillus, this latter in only a very limited number of colonies. The gland in question, which was slightly swollen, juicy, and red, was placed in saturated solution of perchloride of mercury for 1–2 minutes, whereby the superficial layers became opaque and thoroughly disinfected. It was then taken out and wiped with sterile cotton wool and cut in two with sterile scissors. From the middle of the cut gland a small piece was excised and transposed, by a platinum wire previously sterilised, on to the surface of sterile broth Agar-mixture, set with slanting surface in a test-tube. The excised piece of gland having been rubbed over the surface of the Agar, was transferred, again by the platinum wire, to another similar tube, and likewise rubbed over the surface of the Agar, and in this way a number of tubes were inoculated one after the other. Of eight tubes thus inoculated, in three a few opaque white colonies (altogether seven) developed, all except one being colonies of the Klebs-Löffler bacillus, as was proved both by microscopic examination and by subcultures in various media.

In dealing with diphtheritic membranes a particle was placed in a few CC of sterile salt solution and well shaken, and with a fraction of a drop of this, Agar-plate cultivations were made; or a droplet was removed with the hooked end of a platinum wire from the salt solution mixture and rubbed well over the surface of Agar-mixture solidified slantingly in test tubes.

As must be obvious from the fact that, besides the Klebs-Löffler bacillus, some other species of bacteria are present in the diphtheria membrane, it is often necessary to establish several plates and to inoculate a considerable number of tubes in order to obtain the desired colonies of the Klebs-Löffler bacillus entirely free from other organisms. That the colonies which I obtained from the cervical lymph-gland in a particular case were really those of the Klebs-Löffler bacillus, was soon proved by their cultural characters in different media as well as by their morphological characters. Their cultural characters on the surface of Agar are shown in the accompanying illustration [Fig. A., p. 442], and their morphological characters are exhibited in the photographs Nos. 1 and 2, prepared by Mr. Andrew Pringle from suitably stained specimens.

its cultural characters,

As has been already mentioned, the Klebs-Löffler bacillus does not grow on or in nutritive gelatine at 20° C., nor on steamed potato, and the bacillus which I isolated from the cervical gland was of this nature. In gelatine kept at 35°–37° it showed growth, as does the Klebs-Löffler bacillus. After a couple of days the gelatine (being of course fluid at this temperature) shows a uniform but slight turbidity, which never becomes pronounced, and after about 3–4 days a yellowish-grey powdery or flaky precipitate is noticeable at the bottom of the fluid medium, and similar flakes and granules are noticed at the sides of the vessel. The behaviour of this bacillus in alkaline broth is very much the same; there is never any pellicle formed on the surface. At the end of a few days to one week at 35° C., the maximum of growth has been reached. On alkaline broth Agar-mixture the behaviour of this bacillus is the same as that ascribed to the Klebs-Löffler bacillus. It ought to be added that in tubes, the mouths of which are closed by india-rubber caps, the marginal portions became after a few weeks of a brownish colour.

Microscopic examination of fresh specimens and of cover-glass specimens of the bacillus obtained by me, after staining in the usual manner, leaves no doubt about its being the true Klebs-Löffler bacillus. There

are, however, a few morphological points which I think were not correctly interpreted by Löffler.

and morphology.

Löffler, and others (Flügge and Baumgarten) with him, regards as involution forms the granular bacilli, as also those which show at one or both ends a slight enlargement. This is not, I think, quite correct. There is no doubt that in cultures which have ceased for some days to grow, and even in cultures before this point is reached, one meets with forms which are conspicuous from the thickness from end to end of the bacillus, or forms that are enormously (three or more times) enlarged at one end. Such forms as these may or may not be (most probably they are) involution forms; but I have specimens in my possession, from growths only three or four days old, incubated at 36° C., containing very numerous forms which exhibit in a pale sheath numerous granules, either spherical or short and cylindrical; in fact in well stained (Weigert's gentian violet) and well washed specimens, this segregation of the protoplasm of the bacilli within the sheath into spherical, angular, or cylindrical granules, is the rule. I have seen as early as after only 24 hours' growth an indication of this segregation, and therefore I can hardly think that these can be really involution forms. The number of bacilli with slightly swollen end or ends is indeed small in cultures only 24 hours old, but the appearance is not at all rare after 2 days' incubation, and is, I may say, not uncommon in cultures 3 or 4 to 6 days old. Later on, say after 10, 12, or 14 days, the number of bacilli with a club-shaped extremity, or swollen at both ends, is considerable. Amongst these one then meets with bacilli of considerable length, many times the length of bacilli during the first two or three days, having a thin filament at one end and gradually enlarging into a knob at the other. In cover-glass specimens made from cultures nearly a fortnight old well stained in Weigert's gentian violet or Löffler's methyl blue, and then well washed in alcohol and water, there are found numerous bacilli—thin and thick, short and long, cylindrical and club-shaped—which possess within a pale slightly stained sheath a central or terminal deeply stained granule. These are very characteristic; in the cylindrical bacilli there is generally only a single such granule situated in the middle, or perhaps there is one at each end; in the club-shaped bacilli there is generally one large deeply stained granule in the enlargement, and perhaps also one at some point in the cylindrical portion of the organism, the remainder of which is pale and but faintly stained. Such bacilli much resemble other bacilli in what is known as their spore-bearing condition. But drying and heating (60° C.) experiments disprove that these granules are spores, since by those processes they are killed. Many of the bacilli when taken from the cultures appear to be slightly curved; this appearance is less pronounced in very recent cultures, in which the bacilli are short, but is more conspicuous in cultures several days old, though at all times there are numerous examples which are quite straight. The curved condition is best seen in some of the long club-shaped examples. The bacilli have rounded ends even when they are cylindrical, and of course in those with one end or both ends enlarged (club-shaped), the rounded condition is most conspicuous.

III. *Experiments on Animals with Cultures of the Klebs-Löffler Bacillus.*

Experimental inoculation of subcultures of Klebs-Löffler bacillus.

With the above cultures of the Klebs-Löffler bacillus obtained from the cervical glands of a typical acute diphtheria case, a series of experiments were made:—

(*a.*) The cornea and the abraded mucous membrane of the fauces of four rabbits were inoculated with a particle of material from an Agar culture. No result.

(*b.*) Two pigeons were similarly inoculated on the previously abraded mucous membrane of the fauces and of the entrance of larynx, with a particle of material from an Agar culture. No result.

(*c.*) From a broth culture of the bacillus, two days old, and from an Agar culture three days old, I inoculated into the abraded mucous membrane of the fauces and the entrance of the larynx, two fowls and two pigeons. No result.

(*d.*) With the same broth culture and Agar culture I inoculated four guinea-pigs in the abraded mucous membrane of the fauces, and in scarifications of the skin over mammary glands. No result.

(*e.*) Two guinea-pigs were inoculated subcutaneously in the groin with the broth culture. They were both dead on the third day, and post-mortem showed swelling and hæmorrhagic effusion at the seat of inoculation; both lungs, liver, kidney, and particularly the suprarenals much congested; peritonitis; spleen dark coloured.

(*f.*) Four rabbits were inoculated with the broth culture in several incisions of the skin of the ear, and on the abraded cornea. No result.

(*g.*) In two rabbits tracheotomy having been performed, a particle of an Agar culture of the bacillus was rubbed into the abraded mucous membrane of the trachea, and the wound in the trachea stitched together, as also the wound in the skin itself. On the 12th day the rabbits were noticed to have each a small purulent abscess under the skin at the site of the wound. The animals were then killed; the trachea was found in each instance to have completely healed, and the mucous membrane to have become perfectly normal.

(*h.*) Into the jugular vein of four rabbits there was injected one Pravaz syringeful in each case, of an Agar culture of the bacillus distributed in sterile salt solution, and forming therewith a milky fluid. No result.

(*i.*) Two rabbits were inoculated subcutaneously into the groin with a few drops of a broth culture of the bacillus. No result.

Summary.

The outcome of the foregoing experiments may be summed up as follows:—

(1.) Cultures of the Klebs-Löffler bacillus proved virulent to guinea-pigs on subcutaneous injection into the groins of these animals, and the appearances after death were those described by Löffler. This suffices to show that the cultures were active, and had not become in any sense attenuated or bereft of pathogenic power.

(2.) The *same cultures*, just like the diphtheritic membranes itself, proved perfectly *inactive* when applied to the abraded cornea, to the abraded cutis, or to the abraded mucous membrane of the fauces of rabbits.

(3.) The *same cultures*, just like the diphtheritic membrane itself, proved wholly inactive when applied to the abraded mucous membrane of the fauces and entrance of the larynx of fowls and pigeons.

(4.) The *same cultures* proved inactive when applied to the abraded mucous membrane of the fauces of guinea-pigs.

(5.) The *same cultures* proved inactive when injected into the jugular vein of rabbits.

Hence I am unable to admit, either for diphtheritic membranes or for cultures of the Klebs-Löffler bacillus, any specific diphtheritic action on fowls, pigeons, rabbits, or guinea-pigs.

There has been frequently observed by various sanitary officers associated incidence, at or about the same time, of diphtheria on human beings and throat illness on cats; sometimes the cats have been affected antecedently to members of the families to which they belonged; at other times the cats suffered coincidently with or subsequently to inmates of invaded dwellings. Hardly anything is known of the anatomical features of this cat malady, though it has not unfrequently proved fatal to this animal. Cats therefore seemed to offer themselves as promising subjects of experiment.*

Cats in their relation with diphtheria:

IV. *Experiments on Cats with the Klebs-Löffler Bacillus.*

(*a.*) With cultivation on Agar-mixture, and in broth, of the Klebs-Löffler bacillus, two cats were inoculated in the abraded mucous membrane of the trachea.

One of these animals was found dead on the fourth day. Post-mortem, there was extensive emphysema under the skin of the neck, chest, and abdomen, with purulent infiltration of the subcutaneous and muscular tissue of the neck and chest; the emphysema and purulent infiltration started from the wound, which was one mass of pus. Both lungs were congested, and in some parts their surface was covered with purulent pseudo-membrane; also there was emphysema and purulent infiltration of the posterior mediastinum. The second cat died on the eighth day. Post-mortem, there was at the site of the wound a small cutaneous abscess; but the wound of the trachea had healed, and, except a slight redness of the mucous membrane in the region corresponding to the wound, there was nothing abnormal noticeable; certainly there was no pseudo-membrane. Both lungs showed extensive lobar pneumonia; the liver and spleen were congested.

Inoculation of cats with Klebs-Löffler bacillus.

From the inflamed lung tissue of this cat I inoculated a number of tubes, some containing gelatine, others Agar-mixture; and in one tube I obtained a pure culture of a white staphylococcus, which though growing well on gelatine did not liquefy it. No other organisms made their appearance.

(*b.*) The abraded mucous membrane of the fauces and corneæ of two cats were inoculated with broth and Agar cultures of the Klebs-Löffler bacillus. No result.

(*c.*) Two cats were inoculated subcutaneously with broth and Agar cultures of the Klebs-Löffler bacillus. No result.

(*d.*) Into the jugular vein of each of two cats, two Pravaz syringefuls of a milky mixture of the same Agar-culture and salt solution were injected. No result; the cats remained well.

From these experiments I conclude that cultures of the Klebs-Löffler bacillus produce no specific effect in cats; the fatal result, in the first two experiments, having been manifestly due to secondary purulent infection from the experimental wound in the skin and subcutaneous tissue.

Results.

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* Several pathologists and sanitary observers (Gerhard, Von Emmerich, Dr. Turner, and others) have maintained a relation to exist between diphtheria in the human subject and a peculiar necrotic disease of the fauces of pigeons and fowls. According to Löffler, however, this process in the fowl and pigeon is altogether different from human diphtheria, and quite recently Pfeiffer (Zeitschrift für Hygiene, 1889) has come to the same conclusion.

V. *Experiments on Cats with human diphtheritic Membrane.*

Inoculation of cats with human diphtheria material;

I now come to a series of experiments which yielded very striking results; in fact I may say the only definite results that I have so far obtained with diphtheritic material.

Having selected cats for experiment with human diphtheritic membranes, small particles of such membranes obtained from acute cases of typical diphtheria were rubbed on the centre of the corneæ of some of these animals, the anterior epithelium of the region thus inoculated having been previously scraped off. In addition the right palatine arch of each cat was abraded, and a particle of the diphtheritic membrane rubbed on it. For control experiment the same preliminary scrapings were performed on other cats, but nothing was rubbed into the cornea and fauces, except in a few instances some non-infectious muco-purulent matter. These control experiments gave entirely negative results; a slight congestion of the conjunctiva and of the palate, which passed

positive results

off in 24 hours, was all that occurred to these cats. But in those animals into which particles of diphtheritic membrane had been rubbed, a very decided positive result followed. After 24 hours the conjunctiva was found congested, as also the mucous membrane of the palatine arch and its neighbourhood. After 48 hours the conjunctiva was greatly swollen and congested, and the eye closed; at the inner canthus there were lumps of muco-purulent discharge. Upon opening the eyelids the centre of the cornea, that had been denuded of epithelium, was found opaque. The inoculated palatine arch was by this time conspicuously swollen and red; it looked as if superficially ulcerated and was covered with a whitish-yellow film. After 72 hours the affection of the conjunctiva and cornea was considerably advanced; there was much congestion and œdematous swelling of the conjunctiva, and at the internal canthus lumps of purulent matter. The nictitating membrane and the conjunctiva palpebræ too were covered with a purulent film; the cornea was opaque almost in its whole extent, and covered with a film of purulent matter. In the centre of the cornea was an ulcer, and the tissue of the substantia propria at its borders was loosened and flaky. So also there was in the palatine arch by this time considerable advance of the disease process; the swelling and redness were more conspicuous, the arch showing an ulcer covered with a thin yellowish membrane, rather closely adherent. This affection of the palatine arch steadily increased in severity till the 8th or 10th day, and then began to decrease. Towards the end of the second week, the palatine arch had resumed its normal diameter; and upon it no ulcer or membrane could now be seen. The disease of the eye meanwhile also steadily progressed, always for a week or more. Sometimes during the second, sometimes during the third week, the congestion and swelling of the conjunctiva began to decrease, as did also the purulent discharge; and thereafter the eye soon became once more open, the opacity and swelling and loosening of the cornea gradually decreased, and in the end the eye resumed its normal aspect. The date at which this occurred, however, depended on the severity of the process at starting; for I have had cases in which by the end of the second week the conjunctivitis, the discharge, the ulcer, and the opacity of the cornea had not yet reached their climax. In one case, at the end of the second week the cornea still showed an extensive ulcer occupying its central half,—an ulcer so deep that it perforated on a slight touch; in this case the eye was closed, the conjunctiva was greatly congested, œdematous, and secreting much purulent discharge, while the tissue of the cornea surrounding the ulcer was swollen and loose.

VI. *Experiments on Cats with diseased Tissue of Cats of the previous Series.*

That the disease which was produced on the palates and the corneæ of cats, by the application of diphtheritic membrane, is essentially an infectious disease was proved by transmitting this induced malady of the experimental cats to healthy cats.

Induced disease transmissible from cat to cat.

A cat of the previous series, viz., one inoculated with human diphtheritic membrane, had on the eighth day her right eye much inflamed, an opaque cornea, with an ulcer thereon and on her palatine arch an ulcer covered with thin membrane. With scrapings from the palatine ulcer and from the opaque cornea of this cat, the cornea and palate of a healthy cat were inoculated.

On the third day the inoculated eye was found closed, the conjunctiva greatly injected and œdematous, with much purulent matter at the inner canthus; the cornea was opaque and covered with purulent film; the palatine arch was much injected and showed indication of a commencing ulcer. The disease both of the eye and palate was more intense still on the fourth day. On the sixth day the eye was intensely inflamed, with a large amount of muco-purulent discharge from the inner canthus and from nostril of same side; the mucous membrane of the fauces was much congested and covered with muco-sanguineous matter.

Two additional cats were inoculated on the corneæ with the scrapings from the cornea and palate of a cat successfully infected 11 days previously with human diphtheritic membrane. In both these animals exactly similar positive results were obtained. On the third day the infected eyes were closed and much inflamed, the corneæ were opaque, the conjunctivæ injected and swollen, and there was in each instance muco-purulent discharge from inner canthus. One of these cats died in the night of the fourth day. On post-mortem the eye was found much inflamed with purulent membrane on the conjunctiva and on the cornea; the latter was opaque; the mucous membrane of the nasal cavity was injected, as was also the mucous membrane of the fauces, which were covered with muco-purulent matter.

The inference to be drawn from these last two (V. and VI.) series of experiments, is that it is possible to produce by the application of human diphtheritic membrane to the corneal conjunctiva and to the palate of cats, a severe inflammation running a definite course and associated with ulceration of the inoculated tissues and formation thereon of purulent membrane; and further that the disease thus induced is itself in turn transmissible to healthy cats. On the other hand, the diseased condition referred to is not producible by application of non-diphtheritic purulent matter in the same manner to the same organs. It must, however, be stated that the disease thus induced in the cat bears only a slight resemblance to typical human diphtheria; the characteristic thick firmly adhering whitish membranes are not present in the induced cat malady.

VII. *Micro-organisms present in Diphtheria.*

Micro-organisms present in diphtheritic membranes.

Examining cover-glass specimens of diphtheritic membranes, dried and stained in Weigert's gentian violet, I was struck in several instances by the presence of large numbers of minute bacilli. These were not

Their bacilli.

the Klebs-Löffler bacillus, being shorter, and their ends were not generally so rounded as are those of that organism; on the contrary, many were somewhat pointed at one or both ends, and these look like short cones. Some of the longer bacilli showed segregation of the protoplasm within the sheath,—as two, three, or more small deeply stained granules of unequal size. Some of the shorter bacilli also showed one or two such granules. These longer bacilli are hardly distinguishable from streptococci, and but for the presence of intermediate forms might easily be mistaken for them. In some membranes from acute typical diphtheria cases, these bacilli are very numerous; they occur in larger and smaller clumps, and besides are scattered about singly and in isolated groups of two's and three's. Some individual bacilli are slightly curved and some of the longer ones are bent in an angle or in a curve. Chains of these thin bacilli are also met with. Their chief distinguishing character (in cover-glass specimens) from the Klebs-Löffler bacillus, is that many of them are shorter than that organism. But from study of their morphological particulars no definite conclusion can be drawn. Certain observations however made on the corneæ of the cats above described have, along with cultivation experiments, helped to throw a considerable amount of light on these bacilli.

It has been shown in the experiments described on p. 435 that whereas cultures of the Klebs-Löffler bacillus failed to produce any result when applied to the scraped anterior surface of the cat's cornea, application to the denuded cornea, of diphtheritic membrane, produced very definite and severe infective disorder there. On removing flakes from such an infected opaque cornea in the region of the ulcer, and on preparing them as cover-glass specimens (dried in a thin layer and stained with Weigert's gentian violet) there are found among numerous pus corpuscles and detached epithelial cells, large numbers of minute thin bacilli. These bacilli are in fact in pure cultivation on the cat's cornea; in some of the flakes they occur in continuous masses, and no other or almost no other bacteria are present along with them. The suggestion therefore at once presents itself that they stand in some intimate relation to the disease process. The muco-purulent discharge at the inner canthus, as also the purulent film on the conjunctiva, does indeed contain numbers of other bacteria, chiefly micrococci, as is shown by microscopic examination and by culture experiments; but if after wiping off the film from the anterior surface of the ulcer of the cornea, flakes are removed from the tissue of the ulcer itself, or from the surrounding loosened and opaque cornea tissue, and are prepared as cover-glass specimens, the minute thin bacilli previously mentioned will be found, as has been said, alone or almost alone in such samples. Many of these bacilli are distinctly curved or bent, but on careful examination such curved forms are almost always resolved by the oil immersion lens into two or three bacilli stuck together endwise. Some of these curved examples are short, not unlike comma bacilli, and the curve may be slight or it may be almost semi-circular; some too are much longer than others. Amongst the large groups of organisms occurring in flakes of the cornea, bacilli are found of various length, as for instance of that of a mere granule to that of the tubercle bacillus. Some bacilli occur singly, others are in chains; some are made up of two, three, or four elements, more or less curved or bent. They are all of exactly the same extreme thinness, and being in clumps and groups proclaim themselves as belonging to the same species. But for their thinness these bacilli of the corneal tissue of the cat do not differ morphologically from the bacilli I have described as found by me in diphtheria membranes from the human subject. Many of the longer

forms show their protoplasm segregated into granules and look like streptococci.

Artificial culture of these:

By using such flakes—ascertained by means of cover-glass specimens to contain hardly any organisms besides the bacilli—for making artificial cultivations, there is no great difficulty in obtaining the organisms in pure culture. Particles of flakes of the opaque ulcerated cornea are introduced in the usual manner on to the surface of nutritive gelatine, or nutritive Agar broth peptone, or Agar meat infusion peptone mixture; the nutritive materials being contained in test-tubes, and so solidified as to present a slanting surface. By means of the platinum wire the particle is rubbed over the surface of this solid medium in the test-tube, is then transferred to the next test-tube, and here also well rubbed over the surface of the nutritive medium, and so on. In this way a series of cultures are established. After a few (2–3 or more) days' incubation, one notices in many tubes several colonies; in one tube they may be abundant (I counted in some such tubes as many as 25–30), in other tubes they are less numerous. Occasionally the colonies present in a tube are of two kinds. One kind of colony, found most often in Agar tubes, grows rapidly, showing rounded opaque particles, which on microscopic examination turn out to be micrococci; such colonies are, as I have said, few, and are not present in all tubes. But the other kind of colony, consisting of bacilli, is present in all tubes in which growth has taken place at all (in some of the series there are tubes which remain free of any growth), and even in those in which colonies of micrococci occur this other kind is predominant. After two to three days at 37° C., the growths are just visible as minute white specks in transmitted light; after three and four days they are plainly visible, though they are still small, not larger than the head of a small pin. When examined under a magnifying glass or a low power of the microscope, they are translucent brownish, slightly angular, flat discs, granular in aspect, and possessing a characteristic dark opaque punctiform centre. The discs present a difference in aspect on Agar broth and on Agar glycerine and meat infusion; in the former they are less flat than in the latter, and do not after three or four days show the characteristic contrast between dark centre and translucent periphery, being indeed of almost uniform thickness in this medium. On the Agar broth mixture the colonies are more rounded, larger, and grow more rapidly than on the Agar glycerine meat infusion. In the latter medium they are small, and after three or four days are not evenly rounded, but are distinctly crenated. By the end of a week the maximum growth is reached; the largest colonies do not measure more than 1 to 1·5mm. in diameter; their outline under a glass is distinctly crenated; in the centre is a characteristic dark granule. The colonies on Agar broth peptone seem moist as compared with those of the Klebs-Löffler bacillus grown on this medium, and they are less opaque, as well as less white, than colonies of that organism, but except for these small details are easily mistaken for colonies of the Klebs-Löffler bacillus, and I am very much inclined to think that some recent observers, isolating the organisms of diphtheritic membranes by Agar plate-cultivations, have actually mistaken this organism for Klebs-Löffler bacillus.

their morphology.

On microscopic examination of the above cultures, they are found to contain numerous bacilli very similar to those obtained from the corneal tissue of the experimental cats; indeed in all respects except one they appear identical with them. The single particular in which they differ is in their thickness; the bacilli of the cultures are at least twice the thickness of the bacilli obtained directly from the corneal flakes. This

circumstance, suggestive as it is of specific difference of bacilli from the one and from the other source, led me to devote much time to attempts at further differentiating the two sets of organisms; but I have been unable to do so, and in the end have satisfied myself that they are really of one and the same species. The fact, therefore, of morphological change under subculture of the bacilli from the cat's corneal tissue must needs be accepted, and with it this further and more important fact, namely, that by the change thus induced these bacilli have in a morphological sense become absolutely identical with those obtained from the false membrane of diphtheria in the human subject.

Some additional observations that I made in my extended examination of the bacilli of the above cultures deserve notice. In the cover-glass specimens forms occur which are distinctly thin at one end and swollen and thick at the other. These somewhat resemble Löffler's bacillus; but on careful examination with $\frac{1}{2\,0}$ oil immersion lens the thin ends of the cat bacilli are found to differ therefrom in being more or less pointed, and many of the straight forms are pointed or truncated at both ends thus resembling a single or double cone. Some of the bacilli have within a slightly stained sheath one, two, or more deeply stained granules of different sizes, either round or rod-shaped, and not easily distinguishable from streptococci. That all these various forms belong to one and the same species is proved by the fact that they are found together in the same single colony, and from the circumstance that on further subculture they produce without fail similar colonies containing all the above forms.

On comparing cover-glass specimens from cultures in each instance of the Klebs-Löffler bacillus and of the cat bacillus, a great similarity is no doubt noticed as regards size, curved condition, and in the circumstance that many bacilli from both sources are made up of granules and look like diplococci and streptococci. But *whereas the Klebs-Löffler bacillus does not grow on nutrient gelatine at* 20° *C., the cat bacillus grows well on this medium at this temperature.* In *streak* culture this organism forms on nutrient gelatine after several days a thick white band along the line of inoculation; its aspect is moist, its outline nobbed and irregular (Figs. B. and C.). In *stab* culture, the stab after a few days is noticeable as a white line of small globules, which in transmitted light are of a brownish colour: the upper end of the stab is covered with a small whitish plaque (Fig. D.). In gelatine plate culture the colonies are noticeable after 2–4 days as small whitish droplets of circular outline, brownish in transmitted light. The gelatine is not liquefied. On Agar the growth is very similar to that of the Klebs-Löffler bacillus, but growth is quicker. *In broth it causes great turbidity in as short a time as* 24 *hours.* On potato it grows at 36° C., as a thin whitish film, difficult to detect by the naked eye.

While this paper is passing through the press, experiments are in progress for ascertaining whether pure cultures of this cat bacillus are capable of transmitting the cat malady. Thus far positive results have been uniformly obtained with subcultures of the first and second remove from the original source, *i.e.*, the cat's cornea; with later removes positive results have not always ensued. Details of these further experiments will appear in due course in my next paper on the subject of diphtheria.

DIPHTHERIA.

Three plates [Figs. A.–D. and photographs 1 and 2] illustrative of foregoing Report, App. B., No. 2.

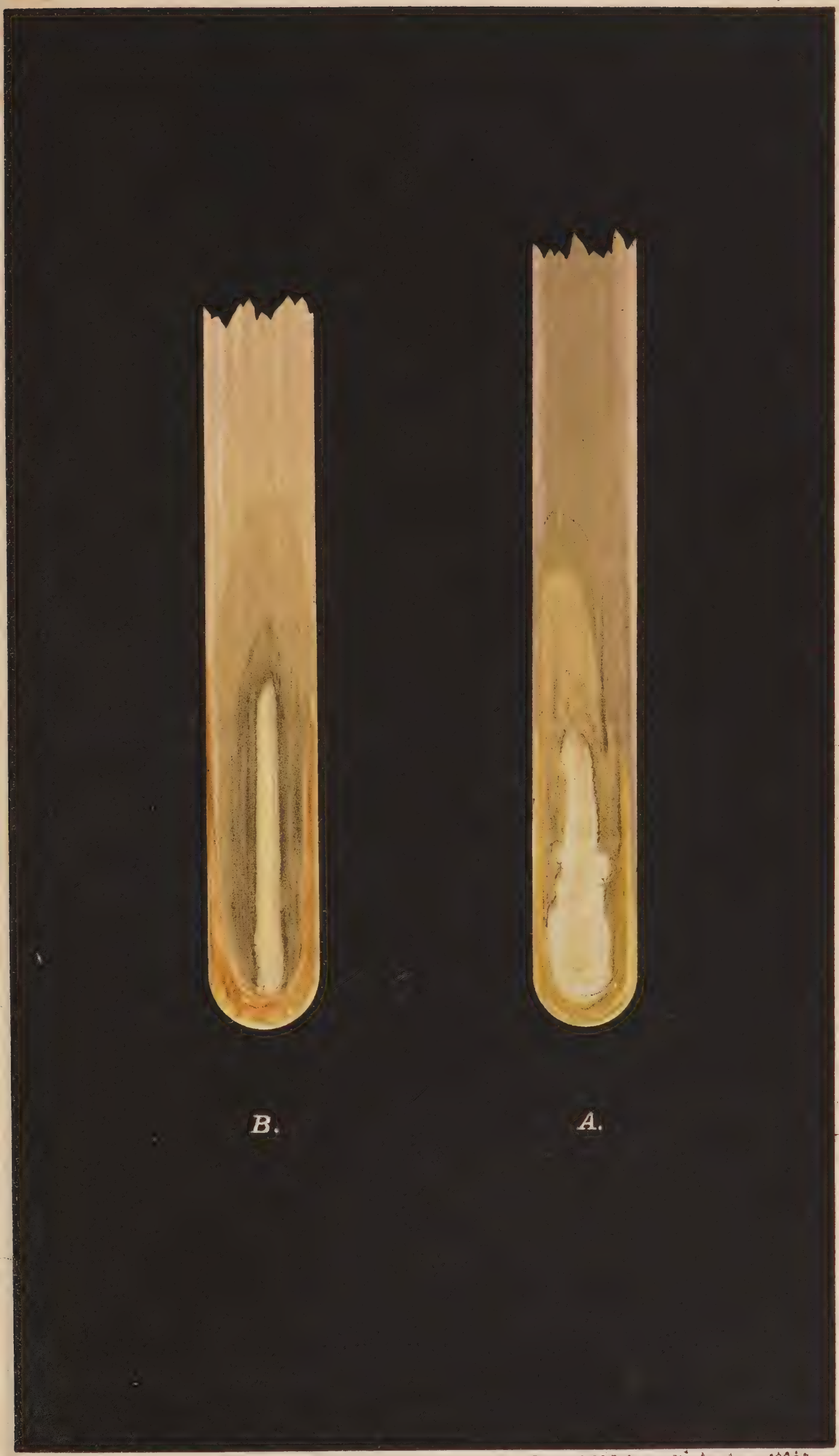
ETIOLOGY OF DIPHTHERIA.

Fig. A.

Streak-culture on Agar of the Klebs-Löffler bacillus after incubation at 37° C. for several days.

Fig. B.

Streak-culture on gelatine of the bacillus of the cat's cornea,—two to four weeks old.



M.H.Lapidge, del

Dangerfield Lithographer London. 1864.



M.H.Lapidge, del

Dangerfield, Lithographer, London. 19264

ETIOLOGY OF DIPHTHERIA.

FIG. C.

Streak-culture on gelatine of the bacillus from the cat's cornea,—after several days.

FIG. D.

Stab-culture in gelatine of the above bacillus.

ETIOLOGY OF DIPHTHERIA.

Photograph No. 1.

Preparation from a sub-culture of the Klebs-Löffler bacillus, a few days old.

[Magnifying power × 1,000.]

Photograph No. 2.

Preparation from a sub-culture of the Klebs-Löffler bacillus, several days old.

[Magnifying power × 1,100.]



Photo 1.

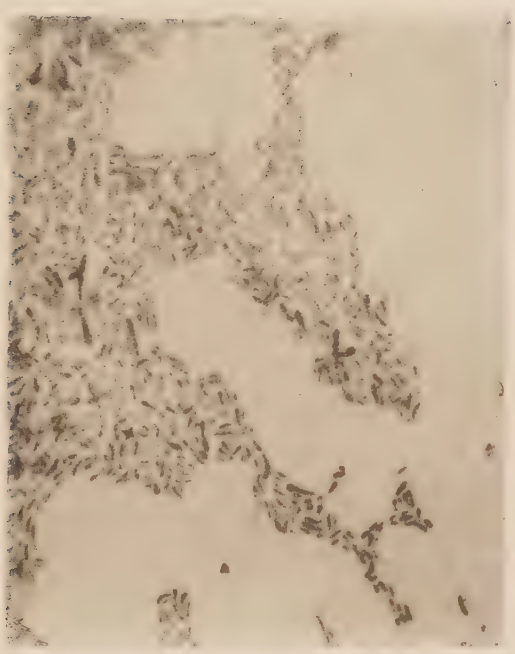


Photo 2.

Banfield, Lithographer, London

App. B. No. 3.

Report on the Influence of Heat upon Micro-Organisms, with especial reference to Differentiation of Spore-bearing and Spore-free Forms: by Dr. Klein, F.R.S.

No. 3.

App. B. No. 3.

On the Influence of Heat upon Micro-organisms; by Dr. Klein.

III.—On the Influence of Heat upon Micro-organisms, with especial reference to Differentiation of Spore-bearing and Spore-free Forms; by Dr. Klein, F.R.S.

In a variety of bacteria the formation of seeds or spores constituting the ultimate phase in their life history is a well-observed fact. The formation of spores has been well described and observed,—in bacillus subtilis by Cohn, in bacillus anthracis by Koch, in bacillus butyricus by Prazmowski and others; so that for a variety of species of bacillus the formation of spores has been established beyond doubt. These spores are formed within the protoplasm of the bacilli under certain favourable conditions (*e.g.*, heat, moisture, oxygen supply) as bright glistening granules, which gradually enlarge into generally more or less oval-shaped corpuscles; in their ripe state they usually are broader than the young bacilli.

Different vitality of micro-organisms

As has been shown by a number of observers, spores offer a peculiar resistance to the ordinary methods of staining, and what is of great practical importance possess a notable ability to resist various inimical influences; as for instance, thorough drying, which kills the non-spore bearing organisms; certain antiseptics, which may be fatal to non-spore bearing forms; and high degree of heat, to which many non-spore bearing organisms are extremely sensitive. For the purpose of this paper it is not necessary to enter into details of our present knowledge on all these points; they have been studied in reference to a great variety of spore bearing bacilli by a host of workers whose researches go to form a considerable portion of the literature on bacteria; on this matter indeed Cohn, Koch, the latter's pupils, and many independent observers, have within the last 10 or 12 years accumulated an enormous amount of interesting and important information. Here it will suffice to note in

Spore-bearing bacteria.

reference to spore-bearing forms that various mobile non-pathogenic bacilli, belonging to a definite group of species (*e.g.*, bacillus subtilis, Jequirity bacillus, and various species of potato-bacillus), produce after two, three, or more days' growth on the surface of alkaline broth or on potato, a scum which consists mainly of felt-like masses of bacilli matted together. In these bacilli active and copious formation of bright glistening spores takes place, corresponding with gradual swelling up and final breaking down of the organisms, whereby the spores are set free. On the surface of solid media (Agar mixture and potato for instance) this accumulation of scum with copious spore formation is especially rapid. Bacillus anthracis, too, grown on solid media (Agar mixture, serum, potato, &c.) forms abundant bright and glistening spores in the well-known threads into which the bacilli elongate.

Bacteria not known to form spores.

But while in many forms of bacilli the formation of spores has been carefully studied and recognised, there are other bacilli, and as well micrococci, vibrios, and spirilla, as to which precise knowledge on this subject is not as yet available. In certain micro-organisms some observers describe, or announce, the presence of spores whereas other observers studying the same organisms question or deny presence of spores in them. To mention two examples only:—(*a*) Gaffky asserts for the so-called "typhoid bacillus" (otherwise the "bacillus of human typhoid fever") ability to form spores. This he in common with other observers infers from the presence in his bacilli of certain cultures (on potato for instance), of bright granules formed at a certain stage of growth of the organism. Buchner, however, shows conclusively that these bright granules have nothing whatever to do with spores. And (*b*)

Hueppe affirms for the comma-bacilli of Asiatic cholera formation of spores—as also arthro spores in spirilla—at a certain phase of their existence; whereas Koch and others after a large series of experiments deny this, and show that these granules or alleged spores, unlike the real well-known spores of other bacilli (*e.g.*, bacillus anthracis, bacillus subtilis, &c.), are killed by thorough drying; and further they deny that any one can demonstrate a power of germination in such granules. It must indeed be obvious that if granules in a particular culture of bacilli are to be accepted as spores, this much is required of them, namely, that when sown into a new suitable culture medium and incubated under suitable conditions, they must be capable of germinating into bacilli. Now for these very comma-bacilli I have convinced myself by a very large series of observations ("Practitioner," 1886) that the granules observed in them by Hueppe are dead matter incapable of germination. In my hands, numerous cultures of the cholera comma-bacilli (surface or streak cultivations on nutrient Agar mixture) after the lapse of four months, though covered with a thick filmy growth which at earlier periods had consisted of masses of living comma-bacilli, were found full of Hueppe's granules. But these granules were absolutely dead matter; when fresh cultures were inoculated with them no growth took place. And so with a variety of other bacilli and micrococci, pathogenic and non-pathogenic. As tests therefore of the presence of spores, mere morphological appearances, reaction to staining, and the like are not to be relied on, except perhaps in the case of well-known species such as bacillus subtilis and bacillus anthracis; and even in regard of these organisms it is extremely difficult under certain circumstances to determine whether particular granules within them are or are not actual spores. Accordingly other and more trustworthy tests have to be employed, such for instance as will determine whether spore-like granules in a particular organism can germinate; whether the organism itself can survive certain drying processes; or whether it can resist a certain degree of heat.

Tests of vitality.

As regards the "germination" and the "drying" tests, there are difficulties in the way of avoiding possible errors which are considerable. As to the process of directly observing under the microscope the germination of granules alleged to be spores, it must be obvious that owing to the minuteness of the objects in question high magnifying powers are required, and that appearances under such conditions are open to misinterpretation,—that they are subject indeed to the "personal equation" of the observer. Similarly, drying experiments are not altogether easy to manage. Unless complete drying of the bacilli or micrococci can be insured, the experiment may yield positive results in the way of revealing the presence of living organisms, for the reason that, owing to imperfect drying, some living individuals will have escaped destruction by the drying process; and no conclusion therefore can safely be drawn as to the presence or absence of spores. Take for instance the case of bacillus anthracis of the blood or spleen of an animal dead of anthrax. If, as Koch has shown, the fluid and blood containing these bacilli are dried on a glass in a film so thin as to contain a single layer only of the bacilli, the bacilli are invariably killed as soon as drying is effected; but if the medium containing them is applied to the glass in a thick layer, the time at which and extent to which the specimen is found barren of life, will of course depend on the rapidity with which the drying process has proceeded, and the facility with which drying had penetrated to the deeper layers. This too has been shown by Koch and others to be true of the cholera comma-bacilli, so that unless thorough drying can be insured a conclusion as to presence

Germination test.

Drying test.

or absence of spores is not justified. In further illustration of the difficulties of this subject, it must needs be noted that each particular specimen has to be judged so to speak on its own merits. Thus, if from a particular living culture a thin layer applied to a cover-glass be thoroughly dried without being exposed to a degree of heat higher, say, than 30° or 38° C., and it be found that a new suitable medium inoculated with this cover-glass remains without growth, we should of course justly conclude that the organism in the particular sample did not contain any spores. Nevertheless, in other cover-glass preparations made at the same time and from the same culture, in which a somewhat thicker layer had been applied to the cover-glass, the results might be different; that is, inoculation of new culture-media with such a dried cover-glass specimen might produce a growth of the organism. But we should not on that account be justified in saying that these other specimens from the same culture contained spores, since it is quite possible, nay probable, that owing to thick application of the culture on the cover-glass the superficial layer having rapidly dried has hereby protected, in the manner of a shield, the deeper layers from the drying process, and by so doing has secured sporeless bacteria in this deeper layer from death.

These points are well understood by bacteriologists engaged in researches of this sort, and different results obtained with material from one and the same culture have habitually to be checked and counter-checked with a view to a judgment as to their real significance.

It follows from these considerations that the test of drying is not altogether unequivocal, that it is not free from objection if precision is wanted in determining the absence or presence of spores. Of course, if the results in a given case are always uniform, nothing more is to be said; but more often the thinness of the layer used, the physical conditions of the material tested, and the method of drying, are not easily brought down to the level of exact and known quantities so as to insure uniformity, and opportunities for variations in the results are therefore commonly abundant. Hence a method by which these difficulties can be easily avoided is a desideratum, and such a method I have, I believe, found in the influence of heat on various bacteria.

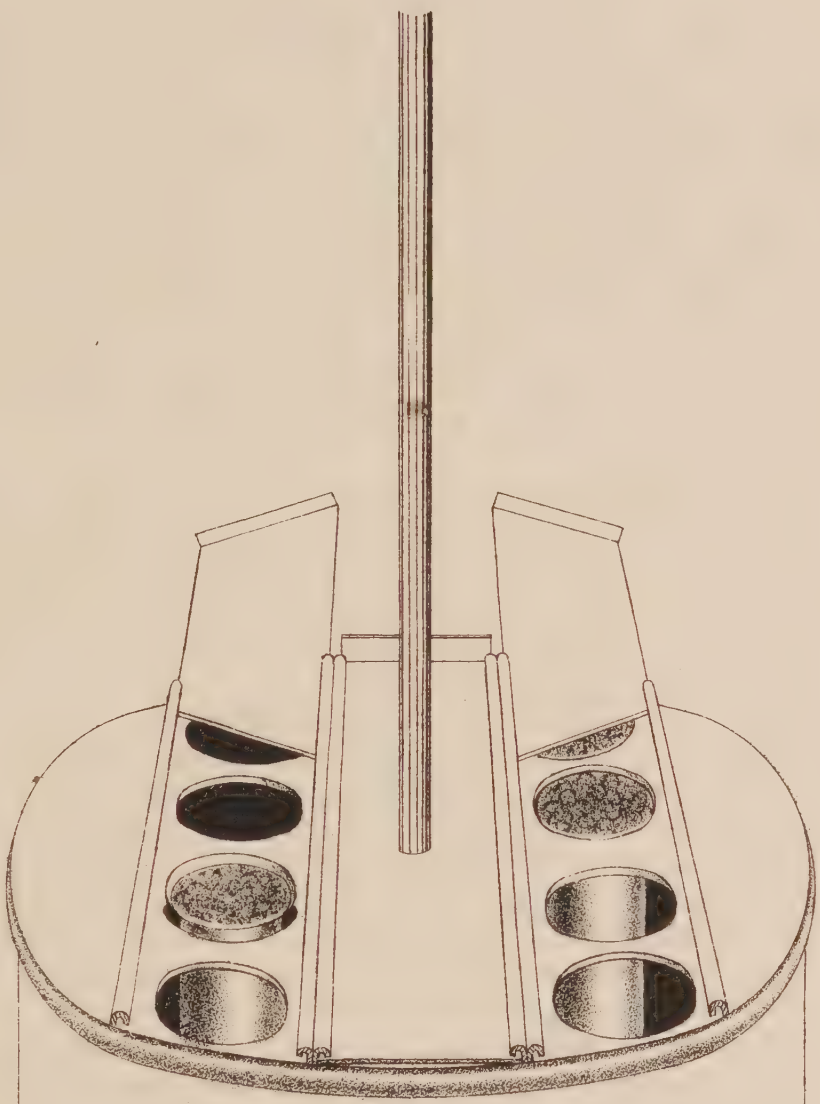
Heat test.

The spores of various species of spore-bearing bacilli have been proved to have a remarkable power of resisting the influence of high degrees of heat, and although ability to resist heat differs widely for the several species, yet every one of them can withstand a short exposure to 100° C., or to the temperature of boiling water, since if sown, after such exposure to heat, into a new suitable medium and kept under conditions favourable to germination and multiplication, a normal and good crop of bacilli will be the invariable result. Cohn found that the spores of certain species of bacillus stand boiling in water for half an hour without thereby being killed, *i.e.*, without losing the power of germination; but that the spores of bacillus anthracis are far less resisting, though they can stand exposure to 100° C. for $\frac{1}{4}$–$\frac{1}{2}$ minute. Now it is equally easy of demonstration, as has been shown by many observers (Chauveau and others), that anthrax bacilli of the blood (which never contain spores) of an animal dead of anthrax are killed by degrees of heat far below 100° C.; by 55° to 60° C. indeed, if prolonged for a few minutes,—a temperature which has no influence whatever on the spores of anthrax bacilli of certain artificial cultures.

In the experiments therefore which I am about to detail I have given special attention to the influence on bacteria of certain degrees of heat; degrees of heat which on the one hand altogether fail in destroying the life of well-known spore-containing bacilli, and which on the other hand

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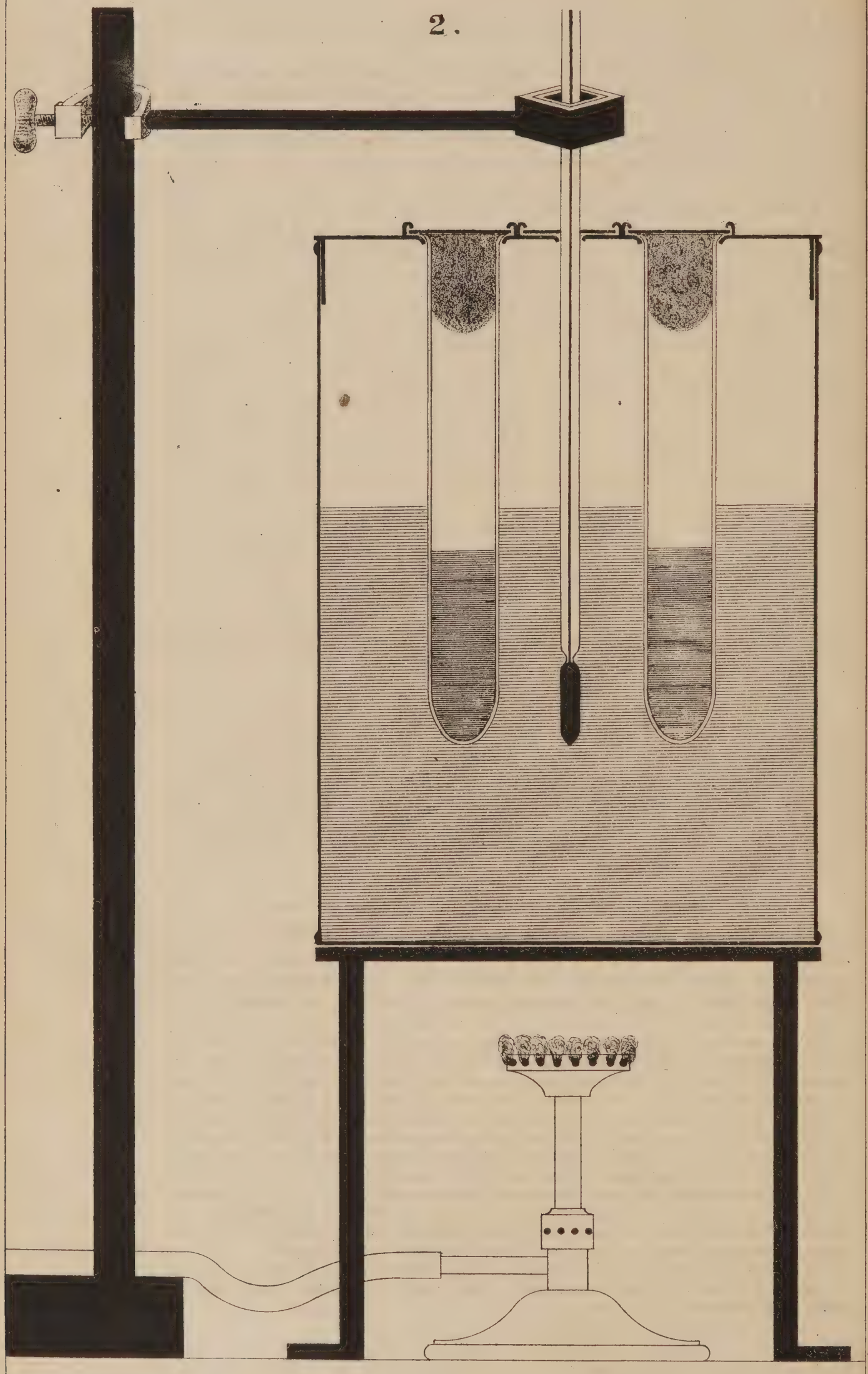
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are known to have a fatal effect on other organisms that have never been found to form spores.

In this investigation, the following simple apparatus (see accompanying drawings) has proved of great use, in that it is thoroughly trustworthy. It consists of a cylindrical vessel of tin capable of holding about four pints of water, and provided with a cover that while easily taken off and put on at the same time fits accurately. This cover is perforated by 13 holes, 12 of them each of a size to allow a test-tube of $\frac{3}{4}$ inch diameter easily to slip in and out, but small enough to grip the test-tube just below its expanded orifice, so that each tube can be kept securely suspended with its lower part, containing culture material and the experimental organism, duly immersed in the water inside the apparatus. The thirteenth hole, which is in centre of the cover, is of size to allow a thermometer easily to slip in and out; a piece of thin india-rubber tubing slipped over the middle of the thermometer enabling the observer to set that instrument in the apparatus at any desired height. The holes in the cover for the test-tubes are in three rows, four in each, the middle row containing in addition the centre hole for the thermometer; and over each row of holes is a tin sliding cover, which can be withdrawn from the holes according as the use of one or more of them is required for insertion of test-tubes. The vessel having been filled with water to within an inch or two of the under surface of the cover, the bulb of the thermometer is pushed down so as to remain at the level of the bottom of the test-tubes that have been introduced through the holes of the cover and suspended in the water. By the flame of a Bunsen burner the temperature of the water in the vessel can be raised to and maintained at any degree up to 100° C. I find no difficulty in regulating the flame so as to keep the temperature of the water constant for hours; the variations observed do not amount to more than $\frac{1}{4}$–$\frac{1}{2}$ of a degree Centigrade.*

Having raised the water to a desired temperature, I inoculate with the organisms to be tested, tubes (6 inches long by $\frac{3}{4}$-inch wide) each containing about 6–8 CC. of sterile faintly alkaline beef-broth peptone. Four tubes are always inoculated with each particular organism, two of the four being exposed to a given temperature in the apparatus,† while other two are kept for control. After exposure of the two experimental tubes to the desired temperature, all four are placed in the incubator and kept there at 36–37° C.

I. *Preliminary Experiments on* Spore-bearing *bacilli.*

Spore-bearing bacilli in their resistance to heat.

(*a.*) *Spores of anthrax*, several weeks old, were introduced into four broth tubes. Two were exposed to 80° C. for 10 minutes, the two others were kept for control. Incubated at 36° C. all four tubes showed after a few days, typical and normal growth of bacillus anthracis.

* Comparative experiments show that the temperature of the broth in the test tubes is about $\frac{1}{2}$–1 degree Centigrade lower than that of the water in the tin vessel; and further they show that when a test tube previously kept at the ordinary temperature of the room is suspended in the water of the vessel, it takes about half a minute for the contained broth to reach the temperature (minus of course the 0·5° C.) of the water. But if the test tubes are previously kept for a minute or two in water of 38° C. it takes only about a quarter-minute for the broth to reach, within 0·5° C., the temperature of the water in the apparatus.

† In all experiments the above mentioned difference of 0·5° C. — 1° C. between the broth in the test tubes and the water in the apparatus is excluded from the number of degrees given in the experiments. Thus, 90° C. will mean 90° C. for the broth in the test-tubes, and 90·5°–91° C. for the water in the apparatus. All test-tubes previous to being placed in the water of the vessel were kept for 1–2 minutes in water of 38°–40° C., and immediately after completion of the experiment the tubes were immersed in cold water.

(*b.*) Spores of anthrax were, in the same way as above, exposed to 85° C. for 10, 20, and 30 minutes respectively. After a few days' incubation at 36° C. all tubes showed normal growth of anthrax bacilli.

(*c.*) *Spores of anthrax* were, in the same manner, exposed to 85° C. for 30 and 60 minutes respectively. After incubation at 36° C. the tubes exposed for 30 minutes showed normal growth of bacillus anthracis, those exposed for 60 minutes remained free of growth.

(*d.*) *Spores of anthrax* were exposed in the same way as before, to 90° C.:—(1) for 15 minutes; (2) for 30 minutes. On incubation both sets of tubes remained free of any growth.

We see then from this, that while exposure for 30 minutes to a temperature at or below 85° C. does not interfere with the life of anthrax spores, an exposure for 60 minutes to 85° C., or for 15 minutes to 90° C., destroys their germinating power.

(*e.*) *Spores* of three different species of "*potato bacillus*" were next experimented with. All these are motile bacilli, liquefying gelatine, and forming in broth, in the course of two to three days, leptothrix threads, which show on the surface as a coherent wrinkled whitish pellicle; in these matted threads there is copious formation of spores. In this experiment the exposure was for 15 and for 30 minutes to a temperature of 90° C. In all tubes on subsequent incubation, normal and typical growth took place.

In regard of heat then, the spores of anthrax bacilli are less resistent than the spores of septic bacilli; in just the same way that they are, as has been shown in former reports, less resistent to certain chemical substances that are used as disinfectants.

II. *Experiments on* Non-Spore bearing *bacilli.*

Spore-free bacilli in their resistance to heat.

(*a.*) With a drop of *blood* of a guinea-pig recently dead of *anthrax*, a number of broth tubes were inoculated. Some of the tubes were kept for control, others exposed: (1) to 70° C. for five minutes; (2) to 80° C. for five minutes. On subsequent incubation, all the control tubes showed typical growth of bacillus anthracis; all the tubes that had been subjected to heat remained entirely free from growth.

(*b.*) From a gelatine tube 4–5 weeks old, containing on the surface copious growth of *Gaffky's bacillus* of typhoid fever, several tubes were inoculated. As before, some were kept for control, others were exposed: (1) to 70° C. for five minutes; (2) to 80° C. for five minutes. On subsequent incubation all the control tubes showed, after a few days, normal growth of this bacillus; all tubes that had been exposed to heat remained free from growth.

(*c.*) From the surface pellicle of a gelatine tube four weeks previously inoculated with the *cholera comma-bacilli*, which by this time had completely liquefied the medium, several broth tubes were inoculated. Some were kept as control tubes, others were exposed:—(1) to 70° C. for five minutes; (2) to 80° C. for five minutes. On subsequent incubation at 36° C., all the control tubes were, after 48 hours, teeming with comma-bacilli, whereas all the tubes that had been exposed to heat remained free from growth.

(*d.*) Similarly, gelatine cultures, 4–6 weeks old, of the *bacillus pneumoniæ* (discovered in connexion with the epidemic pneumonia at Middlesbrough), showing copious growth on the surface, were tested by exposing broth tubes inoculated from the cultures, to 70° C. for five minutes. On subsequent incubation all control tubes showed normal growth of the bacillus pneumoniæ, whereas all the tubes that had been exposed to heat remained sterile.

(*e.*) *Bacillus of swine-fever* from gelatine tubes, 4–6 weeks old, showing copious growth of this organism on the surface, was tested in the same manner and with the same result. Control tubes showed growth, whereas tubes exposed to heat remained sterile.

(*f.*) *Bacillus of swine-erysipelas* from the surface of gelatine cultures 4–6 weeks old, was tested in similar fashion. The result was the same.

(*g.*) *Bacillus gallinarum* was also tested. This organism causes an infectious disease in fowls slightly resembling fowl cholera. It differs however from the micro-organism of that malady as regards its infectivity towards rodents and pigeons, and as regards certain of its cultural characters. This bacillus also was killed by 70° C. if exposed to that temperature for 5 minutes.

(*h.*) The *bacillus* (Klebs-Löffler) of *human diphtheria*. This was taken from old cultures (six weeks old) on the surface of Agar broth peptone, whereon the growth was very copious. The result of exposing broth tubes inoculated with the bacillus to 70° C. for 5 minutes was the same as in the other cases, viz., the tubes that had been exposed to heat remained sterile, whereas the control tubes showed good growth.

(*i.*) The same result was obtained with the *bacillus of mouse septicæmia*, described and figured in previous reports.

From these observations it may be concluded that there is a cardinal difference between notoriously spore-bearing bacilli (such as anthrax and various species of potato bacilli) of Series I., and all these other bacilli dealt with in Series II. And here it requires to be expressly stated that every one of the cultures referred to under *b*, *c*, *d*, *e*, *f*, *g*, *h*, and *i* in Series II. were cultures of several weeks' standing, in which copious and luxuriant growth of the organisms had occurred on the surface, with ample opportunity therefore for free supply of oxygen. These cultures then had been subjected to conditions notoriously favourable for the formation of spores. Nevertheless in no case could the growth resist exposure for 5 minutes to a temperature of 70° C. The conclusion is therefore, I think, justified that these several organisms, viz., Gaffky's bacillus of typhoid fever, the bacillus of swine fever, the bacillus of swine erysipelas, the bacillus pneumoniæ, the bacillus gallinarum, the cholera comma-bacillus, the Klebs-Löffler bacillus, and the bacillus of mouse septicæmia *do not form spores*.

III. *Experiments with Micrococci.*

(*j.*) Streptococcus pyogenes, obtained from chronic abscess.
(*k.*) Streptococcus of human scarlet fever.
(*l.*) Staphylococcus albus liquescens, from acute abscess.
(*m.*) Staphylococcus aureus, from acute ulcer.

Micrococcus forms in their resistance to heat.

Samples of the first two micro-organisms (*j* and *k*), from the surface of good growths on gelatine 4–6 weeks old, and samples also (*l* and *m*) from the surface of good growths on Agar broth peptone, were inoculated into broth tubes. On incubation all of the tubes which had been exposed for 5 minutes to a temperature of 70° C. remained sterile, whereas all the other (control) tubes showed good growth. These different species of micrococci must therefore, from these experiments, also be regarded *as not forming permanent spores*.

Supplementary drying experiments.

In support of the above general conclusions I adduce a large number of "drying" experiments. Dealing with the same cultures which I used for the inoculation of broth tubes in the "heat" experiments, I

have applied, in each instance, a mere trace of culture material to a previously sterilised (by heat) piece of a cover-glass, and have then dried this at 36° C. between two watch-glasses; 30 minutes being found sufficient for this purpose. I then introduced these dried cover-glass specimens into broth test-tubes and incubated them at 36° C. Control experiments were of course made at the same time, a trace of the same culture being applied in each instance to pieces of cover-glass which were, without previously undergoing any drying at all, introduced immediately into broth test-tubes. The results were very striking; not one of the control tubes when incubated failed to produce copious growths, whereas every one of the tubes inoculated with the dried materials remained barren.

In this way I experimented with the several organisms of Series II. and III., namely, (*b*) the bacillus of Gaffky (typhoid fever), (*c*) the bacillus of swine fever, (*d*) bacillus of swine erysipelas, (*e*) bacillus of epidemic pneumonia, (*f*) the bacillus gallinarum, (*g*) comma-bacillus of Asiatic cholera, (*h*) bacillus of Klebs-Löffler, (*i*) the bacillus of mouse septicæmia, (*j*) the streptococcus pyogenes, (*k*) the streptococcus of scarlet fever, (*l*) the staphylococcus pyogenes albus liquescens, and (*m*) the staphylococcus pyogenes aureus liquescens. In all these cases drying, as I have said, completely destroyed the life of the organism.

No. 4.

Report on the Differentiation and Identification of Micro-Organisms inhabiting Soft Moorland Waters that have been found to dissolve Lead; by William Robert Smith, M.D., D.Sc., F.R.S. Ed.

In a memorandum on Lead Poisoning by certain Public Water Supplies, contributed by Mr. Power to the Report of the Medical Officer for the year 1887,* attention is given to some general considerations respecting abilities and disabilities of soft moorland waters to act on lead; and the question is raised, whether the life processes of low animal or vegetable organisms may not be concerned with the problem of how water may obtain, and how it may lose, plumbo-solvent property.

As regards the particular case of Sheffield, where the high-level water service has in recent years exhibited a very pronounced ability to act on lead, Mr. Power summarises a number of observations (and with them certain indications which are seen to be arising) sought out and recorded by Dr. Sinclair White, as follows:—

(*a.*) Plumbo-solvent ability of a soft moorland water;

(*b.*) Exercised as a variable quantity;

(*c.*) Exercised though the production of a chemical change;

(*d.*) Belonging to a limited section, but extending itself to other sections of a water service;

(*e.*) Influenced by conditions of temperature, pressure, and perhaps by other physical and atmospheric circumstances.

The chemical peculiarity of that section of the Sheffield water service which acted most vigorously on lead, was the presence in it of free acid of undetermined nature, and hence the Medical Officer of the Local Government Board directed that the Sheffield and other plumbo-solvent waters should be put to the test of biological experiment, with a view of ascertaining, in the first instance, whether such waters are inhabited by microphytes capable of working by their life processes acid changes in culture media to which they may be transferred.

Accordingly a number of samples of the Sheffield high-level water were taken (date 11th May 1888) in the customary manner in Winchester quart bottles, with all necessary precautions.

Sample A. was from the main tributary to the high-level service reservoir.

Sample B. was from another tributary to the high-level service reservoir, descending from a separate part of the moorland.

Sample C. was from the Redmires high-level service reservoir, before the water had been in contact with the limestone placed there with a remedial intention.

Sample D. was from a stagnant pool on the surface of the peat, in a high part of the gathering ground above the high service reservoir.

Sample E. was from another stagnant pool in a different part of the gathering ground to D.

* Seventeenth Annual Report of the Medical Officer of the Local Government Board. [C.—5526-I.]

The first step in the biological examination of these samples was isolation of the various organisms contained therein, and the next to ascertain whether any, and if so which, of the organisms isolated possessed the power of giving rise to acidity in certain culture media.

Sample A.

This sample was freely acid as tested by litmus paper. On the 16th May 1888 some of the water was taken into a capillary pipette, with the usual precautions to prevent contamination by air, and two plate cultivations of nutrient gelatine were made with three drops only in each of them.

17th May. There was no evidence of growth in either plate.

18th May. Evidence of growth in the plates, but differentiation between the colonies not yet practicable.

19th May. Four different species of colonies could now be distinguished:

No. 1 appeared as a large yellow opaque colony, surrounded by a halo of clear liquefied gelatine.

No. 2 was a white non-liquefying colony rather smaller than No. 1.

No. 3 was a clear liquefying patch having no deposit in the centre as with No. 1.

No. 4 showed as small whitish non-liquefying dots.

Cultivations were made of each of these colonies, both on surface and in depth of gelatine, and, as well, cultivations on Agar-Agar and in alkaline broth.

No. 1 *Colony.*—Was found microscopically to be a motile bacillus. This organism in the course of 24 hours, on the surface of gelatine, grows abundantly as a film having a whitish yellow and fluffy appearance, without liquefaction. After a further interval of 24 hours liquefaction becomes general, with much yellowish white deposit. From this point the liquefaction slowly advances until the whole of the gelatine is liquefied, a slight whitish film occurring on the surface of the liquefied part.

In the depth of the gelatine, the growth was evident as a streak, depressed on the surface, where liquefaction commences and afterward slowly extends downwards.

On Agar-Agar, the organism does not grow at a temperature of 30° C. But at 20° C. it grows as a whitish film over the surface, and in the course of three days the medium is found to have a distinct greenish tinge owing to the diffusion of pigment.

In broth the organism does not grow at a temperature of 30° C. But at 20° C. there is abundant growth in the course of 24 hours, with opacity which increases greatly in the course of the next few days. A slight pellicle is formed extending from the surface of the broth up the side of the tube. This, on shaking the tube, readily broke down and disappeared.

No. 2 *Colony.*—On the surface of slanting gelatine this organism grows as a whitish film, in the thinner parts being more or less dotted. It has a glazy or watery-looking appearance, and in the course of four or five days liquefaction occurs; the liquefied matter collected in the lower part of the test tube is quite clear, and is covered with a slight whitish scum.

In the depth of gelatine this organism appears as a greyish streak, with slight depression at the surface, from which liquefaction slowly descends. On Agar-Agar the organism shows no growth at a

temperature of 30° C. But at 20° C. in the course of 24 hours there is a good growth as a greyish film of closely packed minute dots.

In broth at a temperature of 30° C. the organism grows but feebly, there being but slight opacity of the tubes. At 20° C. there is abundant growth, the turbidity being very great, but there is no pellicle.

This organism is a motile bacillus.

No. 3 *Colony.*—Likewise a motile bacillus, has a tendency to form nodules on the surface of gelatine. It grows rapidly, accompanied by much liquefaction; at the bottom of the liquefied part there is a yellowish deposit.

In the depth of gelatine there is fair evidence of growth as a greyish streak, and on the surface of the medium it spreads as a film having a watery appearance; from the surface liquefaction quickly proceeds, accompanied with much deposit of a yellowish character.

On Agar-Agar at 30° C. there is growth as a greyish film.

In broth there is abundant growth, with a slight attempt at the formation of a pellicle. This, however, breaks up on gently shaking the tube. There is much whitish deposit.

No. 4 *Colony.*—Grows on the surface of gelatine as a film of small closely-placed dots, greyish white by reflected light, and bluish white in colour by transmitted light. Liquefaction arises in the course of three or four weeks.

On Agar-Agar it grows well as a greyish white film at a temperature of 30° C.

In broth at a similar temperature there is abundant growth, but no formation of pellicle. There is a slight whitish deposit.

The organism is a small motile bacillus.

The re-action of the several broth cultivations was now taken with the following results:—

No. 1. Alkaline to a greater extent than the original sterilized broth from which the supply for these cultivations was taken.

No. 2. Same as No. 1.

No. 3. Alkaline, to rather less extent than No. 1, but more so than the original broth.

No. 4. Slightly alkaline, about the same as the original broth.

Sample B.

This water had an acid reaction.

Plate cultivations on gelatine were made on the 21st June 1888 with 10 drops of the water.

A pure culture of a single micro-organism resulted as a white non-liquefying growth.

On the surface of gelatine this organism grows as a film of distinct white dots. In the depth of the gelatine are streaks of dots quite white in appearance and non-liquefying.

On the surface of Agar-Agar the growth appears as a thick white film.

In broth at 30° C. it causes much opacity, without pellicle formation, but a narrow white ring makes its appearance round the side of the tube just above the surface of the broth.

Microscopically this organism is a micrococcus, occurring as diplo cocci, with a tendency to form chains.

Broth cultures of the organism, when tested as to their re-action to test paper, showed but slight alkalinity, rather less than that of the original broth.

Sample C.

This water had a slight acid reaction.

Two gelatine plate cultivations were made with six drops of the water, with the usual precautions, on the 8th July 1889.

12th July. Two distinct varieties of colonies were found scattered over the surface.

No. 1 as liquefying colonies.

No. 2 as small non-liquefying dots.

From these colonies, organisms were isolated in the ordinary way, surface gelatine, Agar-Agar, and broth cultivations being made.

No. 1.—On gelatine, grows as a whitish film, which slowly liquefies, ultimately leaving a clear fluid with slight whitish deposit.

On Agar-Agar growth occurs as a yellowish white film of small dots, with a dark centre and lighter border.

In broth growth is best at the ordinary temperature of the atmosphere; no pellicle is formed, and a slight deposit occurs.

Microscopically the organism is found to be a small bacillus, which is slightly motile.

No. 2.—Grows on the surface of gelatine as small greyish non-liquefying dots; on Agar-Agar as a film of greyish white dots, and in neutral broth opacity occurs in the course of two or three days; slight deposit follows, the supernatant fluid becoming clear; no pellicle is formed.

The organism is found to be a micrococcus.

On testing the broth sub-cultures of these organisms as to their reaction, No. 1 was found to be slightly acid, No. 2 neutral.

Sample D.

This water had acid reaction.

Two gelatine plate cultivations were made in the ordinary way with three drops of the water on the 29th October 1888.

November 1.—Numerous colonies were found scattered over the surface of the medium, which by the 5th November were separable into three distinct groups.

No. 1. group appears as colonies causing much liquefaction, with abundance of white fluffy deposit in the centre.

No. 2 group appears as liquefying colonies with whitish deposit greater in quantity than No. 1.

No. 3 group appears as china white non-liquefying colonies with a whitish yellow deposit.

Each of these three sorts of colonies were further isolated by making separate gelatine tube cultivations of the several varieties, and by sub-culture subsequently on Agar-Agar and in slightly alkaline broth.

No. 1 Colony.—In the course of 24 hours there is evidence of growth on the surface of gelatine as a greyish film, and after a further interval of 24 hours the gelatine is found to be much liquefied with production in it of abundance of white fluffy deposit. The supernatant part of the liquefied gelatine remains clear. The track of the needle in streak cultivation is much hollowed out, a number of whitish spots being seen scattered at intervals along the track.

In the depth of gelatine the organism is found to grow as small dots, with a slight film on the surface, which in the course of 48 hours becomes cupped. Liquefaction then commences, and extends rapidly from above downwards. On Agar-Agar the organism grows at a temperature of 30° C. as a yellowish white film.

In broth, after an interval of 24 to 48 hours, much opacity is present, and on shaking the tube threads appear of a whitish character, which float up through the broth; no pellicle is formed.

Microscopically, the organism is a motile bacillus, which forms spores, and in broth threads.

No. 2 *Colony.*—After an interval of 48 hours much liquefaction is found on the surface in gelatine tubes, with yellowish white deposit. The track of the needle in streak cultivation is perfectly clear, there being no whitish spots, as was the case with the preceding organism.

In the depth of gelatine this organism grows as small dots with a slight surface film. Liquefaction commences at the surface.

On Agar-Agar it grows at a temperature of 20° C. as a yellowish white film.

In broth it grows abundantly, producing much opacity. On gently shaking the tube small whitish particles are seen to float through the fluid.

Microscopically this organism is found to be a motile bacillus which does not form spores.

No. 3 *Colony.*—Both on the surface of gelatine, and on Agar-Agar, this grows as a china white film.

The organism slowly liquefies the gelatine after an interval of two or three weeks.

In broth after lapse of two days opacity is present, with a white deposit, and there is formation of a delicate pellicle as a thick whitish ring round the margin of the tube where it touches the surface of the broth.

Microscopically, this organism is a micrococcus, which in broth forms streptococci.

The alkalinity of these several broth cultures was tested with litmus paper to see if any change had been effected by growth of the organisms in them, and with the following results :—

No. 1. Re-action neutral.
No. 2. Re-action neutral.
No. 3. Re-action alkaline.

Thus showing that these organisms, like those previously described, had not the power of producing free acid in the media employed for their culture.

Sample E.

This sample had acid re-action :—Gelatine plate cultivations were made with two drops of the water on the 29th October 1888.

2nd November. Two distinct colonies were seen.

No. 1, as non-liquefying whitish dots.
No. 2, as liquefying colonies with slight central yellowish deposits.

No. 1 *Colony.*—On the surface of gelatine, in the course of three days, appears as a film of dots, of a greyish character by reflected light and faintly yellowish blue by transmitted light. It does not liquefy the gelatine.

On Agar-Agar it shows a growth greyish white by reflected light and white by transmitted light.

In broth it grows feebly at a temperature of 30° C., but more abundantly at 20° C. It does not form a pellicle or ring.

Microscopically it is a small motile bacillus.

No. 2 *Colony.*—On the surface of gelatine causes in two or three days much liquefaction; the liquefied part which has settled at the

bottom of the tube becoming somewhat opaque, with a deposit of a yellowish character.

On Agar-Agar it grows as white spots raised above the surface. They are circular in outline.

In broth no growth perceptible at a temperature of 30° C. At a temperature of 20° C. the organism grows, but without formation of pellicle.

Microscopically it is an organism occurring in groups of 2, 3, or 4 together, and appears like a micrococcus, but along with this form are found small rod-shaped bodies. The organism is, it would appear, a short non-motile bacillus, the micrococcus character being one stage only of its growth.

Further samples of Sheffield water were collected 7th November 1888 from the same sources as before. In this second series :—

A. X.	corresponds to sample		A.	of the former series.	
B. X.	„	„	B.	„	„
C. X.	„	„	C.	„	„
D. X.	„	„	D.	„	„
E. X.	„	„	E.	„	„

Sample A. X.

The reaction of this water was faintly acid.

Plate cultivations were made of this water, with two, four, and six drops respectively.

After an interval of three days it was possible to isolate Colony No. 1, which was white in colour and did not liquefy the gelatine.

After a further interval of two days, two more distinct colonies were visible.

No. 2 occurred as clear, circular, liquefying patches, each with a whitish spot in the centre.

No. 3 as liquefying growths of a distinctly greenish tint with slight whitish deposit.

Tube cultivations were made of each of these organisms on gelatine, on Agar-Agar, and in broth.

No. 1 *Colony.*—On the surface of gelatine, appears as whitish dots, which after the lapse of a week give rise to much liquefaction. The whitish spots are especially numerous at the margin of the inclined liquefying surface. The liquefied gelatine has a yellowish tint, and there is also a yellowish white deposit; on the surface there is a whitish film.

On Agar-Agar the growth occurs as a whitish grey film.

In broth at 20° C. the growth though evident is not abundant; there is no pellicle.

Microscopically the organism is a small motile bacillus.

No. 2 *Colony.*—In the course of four days, showed much liquefaction, such liquefaction extending half-way up the inclined surface of the gelatine; upon this surface, bluish-white spots are seen. The liquefied portion is whitish having thick particles floating through it; there is likewise a whitish deposit.

On Agar-Agar it grows as an abundant white film.

In broth, at 20° C., much growth occurs with slight deposit, but there is no formation of pellicle.

Microscopically the organism is a motile bacillus. At the ordinary temperature of the atmosphere it grows more abundantly, leaving a clear supernatant fluid with a whitish deposit.

No. 3 *Colony.*—Growth is visible on the inclined surface of gelatine in the course of 48 hours, as a greyish film, which, after a further lapse of 24 or 48 hours, gives rise to much liquefaction. No spots of a whitish character are left on the surface, as in the preceding case. The liquefied part, whilst being much clearer than was the case with Nos. 1 and 2, has a distinct greenish tint.

On Agar-Agar the organism grows as a greyish film, a distinct greenish tint being at the same time imparted to the medium.

In broth, great opacity occurs in the course of a day or two, and the broth acquires a greenish tint. There is no pellicle formed.

Microscopically the organism is a motile bacillus.

The re-actions of these broth cultivations were:—

No. 1. Neutral.
No. 2. Slightly alkaline.
No. 3. Slightly alkaline.

Sample B. X.

Re-action of sample slightly acid. Two gelatine plate cultivations were made with two drops of the water without result, and again on the 16th November 1888 with six drops.

19th November.—Numerous colonies visible, two varieties being distinguishable: the one being represented by clear liquefying colonies, having a circular outline, showing white, central, fluffy deposit, and of a greenish tint, the other by small white non-liquefying colonies.

No. 1 *Colony.*—By subsequent tube cultivations on gelatine, on Agar-Agar, and in broth, and by microscopical examination, this was found to be the motile bacillus so common in water.

No. 2 *Colony.*—By similar cultivation and microscopical examinations, this was found to be the same organism (a micrococcus) as described under No. 3, sample D.

Sample C. X.

This water gave a neutral re-action with test paper.

On the 1st January 1889, and subsequent days, gelatine plate cultivations were made successively with 5, 10, 15, and 20 drops of the water without result.

On the 9th January two plate cultivations were made with 30 drops of the water.

Two organisms were subsequently isolated.

No. 1.—Growing on the surface of gelatine as a film of a greyish white colour; it rapidly liquefies the medium, a whitish deposit being seen in the liquefied part.

On Agar-Agar it grows as a wrinkled grey film.

And in neutral broth, at 20° C., it gives rise to great opacity, much deposit, but there is no pellicle formation.

Microscopically it is a small motile bacillus.

No. 2.—On the surface of gelatine, grows as small, yellowish white dots, which liquefy slowly.

On Agar-Agar, at a temperature of 30° C., it grows abundantly as a film of a yellow colour.

In neutral broth, at 30° C., it grows rapidly, causing great opacity, which, in the course of two or three days, subsides, a yellowish deposit

being formed, and a ring of a yellowish character being formed on the tube near the margin of the fluid, but no pellicle.

The organism is a micrococcus, occurring as diplococci, and in short chains.

The broth cultivations of these organisms were found to have undergone no change as regards their re-action to test paper.

Sample D. X.

This water had acid re-action. Plate cultivations on gelatine were made in the usual way, and four colonies differentiated, namely:—

No. 1. Small non-liquefying colonies of a greyish aspect, and somewhat watery looking.

No. 2. Small liquefying colonies.

No. 3. Chocolate-coloured non-liquefying colonies.

No. 4. White non-liquefying colonies.

No. 1 *Colony.*—Grows on the surface of gelatine, showing in from 24 to 36 hours, as a whitish film, which appears greyish by transmitted light. Liquefaction ensues in the course of three or four days. On Agar-Agar, at a temperature of 20° C., it grows as a greyish translucent film. In broth, it also grows at this temperature; opacity arising in the course of two days, but without formation of pellicle. At a temperature of 30° C. no growth was visible either on Agar-Agar or in broth.

Microscopically the organism is a motile bacillus.

No. 2 *Colony.*—On the surface of gelatine after an interval of 24 hours, a greyish film is visible. This quickly liquefies the medium, leaving large bluish white spots visible on the surface. On Agar-Agar, at 20° C., it grows abundantly as a translucent film of a greyish colour, the growth being more abundant than in the case of No. 1. On Agar-Agar, at a temperature of 30° C., it grows as a greyish translucent film of dots. In broth, at the same temperature, there is good growth, but without formation of pellicle.

Microscopically the organism is a motile bacillus.

No. 3 *Colony.*—In plate cultivation appears as chocolate-coloured circular colonies. On the surface of the gelatine, in tubes, these grow as a film of chocolate-coloured spots, not giving rise to liquefaction. On Agar-Agar, at a temperature of 30° C., a chocolate-coloured film is formed. In broth at a similar temperature opacity occurs.

In broth at the ordinary temperature of the air, growth occurs rather more abundantly, a clear supernatant fluid resulting, with a pinkish deposit.

Microscopically this was found to be a torula.

No. 4 *Colony.*—This organism, on the surface of gelatine, grows as a whitish film, which does not liquefy the medium. On Agar-Agar, and in broth, at a temperature of 30° C., there is no growth; but at 20° C. it grows on Agar-Agar as a whitish film, and in broth at this temperature there is also slight evidence of growth.

At the ordinary temperature of the atmosphere it grows more abundantly, having a clear supernatant fluid with a whitish deposit.

Microscopically the organism is a torula.

In testing the re-action of these several broth cultivations:—

No. 1 was found to give a slight acid re-action.
No. 2 „ „ „ „
No. 3 „ „ decided acid re-action.
No. 4 „ „ „ „

Sample E. X.

This water was very dirty, having much sediment, and giving a neutral reaction.

Two plate cultivations were made with 20 drops of the water, on the 14th June 1889, and after an interval of four days two organisms were isolated.

No. 1, which caused liquefaction of the gelatine, with slight deposit in the centre.

No. 2, which appeared as small non-liquefying dots.

Gelatine tube cultivations were made of each of these organisms, and subsequently broth and Agar-Agar cultures.

No. 1.—Grows as a film of a greyish colour by reflected light, rapidly causing complete liquefaction of the medium, and giving rise to a deposit of a granular character.

At the temperature of 20° C. it grows on Agar-Agar as a greyish white film, and in neutral broth it causes slight turbidity; subsequently small particles of a white fluffy character may be seen floating through the medium.

Microscopically the organism is a small non-motile bacillus, and the re-action of its broth cultures is found not to be changed.

No. 2.—Forms a white film of small dots on the surface of gelatine, which subsequently slowly liquefy the gelatine, and cause a fluffy deposit.

On Agar-Agar it grows as a greyish film, and in neutral broth it causes opacity in the course of two or three days.

The organism is a motile bacillus, having a tendency to form leptothrix, and its broth cultures are found to have undergone no change in their re-action to litmus papers.

As regards these experiments, the most important results are those obtained from examinations of sample D. X.

The chocolate or pinkish torula and the white torula producing, as each does, distinct acidity of the culture medium, may be found by further experiment to have an important significance in the direction sought.

No. 5.

On the Relations of Scrofula, Lupus, and Tuberculosis; by Alfred Lingard, M.B. Durham, D.P.H. Camb.

The affections of the glands and skin known as scrofula and lupus respectively have during the past few years received special attention, since it has appeared probable that they belong to the group of true tubercular diseases.

In the following paper it is my intention—

(i.) To give a brief resumé of the results obtained by previous observers who have experimentally studied scrofula and lupus.

(ii.) To detail the results of my own experiments with the above materials on guinea-pigs, to describe the pathological changes found in these animals, and to note certain inferences arising from the above observations.

I. Bibliography.

A. *Scrofula.*

Nélaton asserts* :—

> L'examen macroscopique et microscopique des lesions scrophuleuses, offrant à l'observation des aspects identiques, la marche clinique de la maladie considérée dans son ensemble établissant un rapprochement de plus en plus intime entre les deux ordres de manifestations, on en vint à conclure qu'elles étaient de même nature, et que les lésions scrofuleuses susceptibles de guérison ne devaient être considerées, le plus souvent que comme des alteratives tuberculeuses à leur début. De lors, le prognostic de la tuberculose sembla singulièrement modifié.

Arloing † states that both guinea-pigs and rabbits are capable of infection by pulmonary tubercular material whilst the material obtained from scrofulous glands only produces pathological changes in the rabbit.

He says his experiments show that the passing of scrofulous virus for two successive generations through the guinea-pig does not enhance its virulence for the rabbit and only very slightly for the guinea-pig. The result when tubercular matter is used in its attenuated form, such as one can obtain from localised tubercle in surgical cases, is different. Passage of tubercular virus through the bodies of guinea-pigs increases its virulence. He goes on to say that this is consistent with the difference established by experiment between these two morbid conditions, and

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* Nélaton.—Thèse présentée au concours de l'aggrégation. Paris. 1883. And Centralblt. f. Chirurgie pg. 1, 1885.

† Arloing.—Sur la virulence de la tuberculose et de la scrofule. Le progrès medicale. 1886, No. 41, October 9th, pg. 843.

that if each be not yet proved to be the work of a distinct virus, it is necessary to admit that the single agent, the tubercle bacillus, possesses different degrees of activity. At any rate one ought, he says, to recognise the fact that the material obtained from scrofulous glands is further removed from its primitive virulence than that obtained from local tuberculosis.

De Renzi* criticizes the results obtained by Arloing, concerning the different pathological results obtained after the inoculation of rabbits and guinea-pigs, with scrofulous material on the one hand, and tubercular on the other. This author sums up the results of his own experiments as follows :—

(i.) That the virus of scrofula is identical with that of tubercle in the results produced in susceptible animals.

(ii.) That material obtained from scrofulous glands produces the same visceral lesions in rabbits and guinea-pigs, especially the deposition of tubercle in the lungs.

(iii.) That there is not the slightest ground for believing that the scrofulous virus is an attenuated tubercular poison.

B. *Lupus.*

Koch† investigated seven cases of lupus, all of which had been marked by the most definite symptoms. From four of these cases he obtained excised pieces of skin, and from the remaining three scrapings of the lupoid growth. Tubercle bacilli were found in all four specimens of skin, though only sparingly distributed in each, and within the giant cells. In two of the four they were not found until 27 sections in one instance, and 43 in the other, had been looked through.

All the above seven lupus cases furnished material for inoculation of the anterior chamber of the eye in rabbits,—resulting, without exception, in tuberculosis of the iris; and where the animals were allowed to live some time, in the development of general tuberculosis with numerous bacilli in the tubercles. Koch likewise succeeded in obtaining a pure culture of the bacillus and produced 21 cultures in 16 months. With these cultures he successfully inoculated animals, and produced a general tuberculosis.

Block, F.,‡ found what appeared to be the tubercle bacillus present in at least 79 per cent. of his 144 cases of lupus.

Sachs, E.,§ found the tubercle bacillus present in 62·83 per cent. of the 105 cases of lupus examined.

Bender‖ examined the material from 159 cases and was able to recognise the presence of bacilli in 62·3 per cent.

Doutrelepont¶ removed portions of lupoid tissue before ulceration had commenced in seven well marked cases of lupus vulgaris, and in each instance noted the presence of bacilli.

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* Re Renzi.—Sull' identità della scrofula colla tuberculosi. (Revista. clin : e. terapeut. 1887. Anno IX. Aprile.)

† Koch, R.—Die Ætiologie der Tuberkulose. Mittheilungen aus dem Kaiserlichen Gesundheitsamte. Zweiter Band. S. 38. Berlin 1884.

‡ Block, F.—Klinische Beiträge zur Ætiologie und Pathogenesis des Lupus Vulgaris. Viertel jahrsch für. Dermatologie und syphilis 1886. Pg. 201.

§ Sachs, E.—Beiträge zur Statistik des Lupus. Viertel jahrsch. für. Dermatologie und Syphilis. 1886. Pg. 241.

‖ Bender.—Ueber die Beziehungen des Lupus Vulgaris zur Tuberculose. Deutsche, Med. Wochenschrift. 1886. No. 23, pg. 396.

¶ Doutrelepont.—(1.) Tuberkel bacillen in Lupus. Monatshefte für pract. Dermatologie. 1883. No. 6. (2.) Lupus und Haut, tuberkulose. Deutsche. Med. Wochenschrift. 1887. No. 43.

The case in which he found the bacilli most numerous was one in which lupus had developed in the scar tissue of a former burn.

The same author at a later date published a second paper, in which, after examining the tissue of a number of fresh lupus cases he states that he has found the bacillus constantly present.

On the other hand Leloir* examined twelve cases of lupus, removing for the purpose a portion in each case of skin from the living subject, with negative results.

At a later date he inoculated fifteen guinea-pigs by placing a piece of lupoid nodule in the peritoneal cavity.

The result in all the fifteen cases was negative; and in addition numerous other observers have examined the lupoid tissues unsuccessfully, and are therefore of opinion that no organisms resembling the tubercle bacillus are to be found there.

Kaposi† stoutly refuses to accept identity of the two maladies, maintaining his doctrine that lupus has nothing to do with tubercle. He says: "I cannot class lupus as tuberculosis of the skin, for there is "an actual tuberculosis of the skin, and this looks quite different. "Cultures have been made, and Koch has reported that by inoculation "of these pure cultivations he has produced lupus. *Quod nego?* If "cultivations are injected into rabbits and nodules follow in the "peritoneum,—that is no lupus; they are nodules of tuberculous "granulation tissue that do not behave in the same way as lupus; "generally speaking lupus has never been produced experimentally."

Schwimmer‡ more recently has followed Kaposi, and sums up his views concerning the different course of symptoms presented by lupus and by tubercular disease of the skin and mucous membranes by insisting upon the following points:—

1. The relative scarcity of tubercle of the skin compared with the frequency of lupus and the singularly different course of development observed in the two processes.
2. Tuberculosis of the skin begins first, almost exclusively on the mucous membrane, from whence it advances to the skin, the contrary being the case with lupus. The bacilli of lupus are very few in number, often 20 to 30 sections being examined without any bacilli being found; in tubercular ulceration of the skin they are as numerous as in tuberculous sputum.
3. The very different influence displayed (if produced by one and the same organism) in the tubercular and lupoid processes, the former being always followed by a general tuberculosis, the latter if so followed being but a coincidence difficult to explain.
4. The bacillary relation, he says, existing between lupus and tubercle is not a subject of confused conjecture; but, as in the case of the leprosy and syphilis bacilli, the maladies are due to totally distinct organisms.

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* Leloir, H.—(1.) Recherches sur l'inoculation du Lupus, Compte Rendu de la Société de Biologie. 1882. No. 44. (2.) Neue untersuchungen uber die Bezielung zwischen Lupus und Tuberkulose.

† Kaposi.—Clinical Lecture on "Lupus and Tuberculosis." Medical Press Circular, 1889, and Transactions of the International Congress, Copenhagen.

‡ Schwimmer, E.—Ueber tuberkulose der Haut and Schleimhaute. Tagebl. d. 59 Versamml. deutschen Naturf in Aerzte zu Berlin. 1886. Pg. 224.

II.—I now pass to details of my own experiments.

Series A.—Scrofulous Material.

Experiment I.

A[1]. A guinea-pig was inoculated in the inguinal region with a piece of a caseous gland removed from the cervical region of the human subject.

Cover-glass preparations of this caseous material, after staining with magenta and decolourising with nitric acid, presented on microscopical examination two or three bacilli stained red on each slide. This animal died in a period of 167 days.

On post-mortem examination several enlarged glands were found just above the point of inoculation, one measuring three-quarters of an inch in length.

Lungs:—pale in colour, with a few grey tubercles scattered over the surface of either lung; on section similar nodules were seen scattered through the substance of the organs.

Liver:—the right lobe singularly free from change, but the left presenting numerous yellow spots and small grey tubercles in an early stage of development, thickly studded over its surface.

Spleen:—enlarged two-and-a-half times its normal size and studded with round yellow tubercles the size of a pin's head.

Kidneys:— no apparent change, either externally or on section.

An abscess was found in the abdominal cavity to the right side of the lumbar spinal vertebræ, in the contents of which were numerous tubercle bacilli; also the enlarged inguinal gland above mentioned, when treated in a similar manner to the one described above, revealed the presence of as many as forty (40) red-stained bacilli in each cover-glass preparation. Some of the rods appeared to be vacuolated.

B[1]. Inoculated guinea-pig with material from caseous gland of guinea-pig A[1] in the right inguinal region.

This animal succumbed in 123 days.

Post-mortem, the animal presented an emaciated appearance, and the inguinal glands were enlarged and caseous.

Lungs:—consolidated, and tubercles scattered over their whole surface, as also in the substance on section.

Liver:—studded with round yellow caseous nodules, some in the right lobe, but mostly in the left.

Spleen:—twice the normal size, and presenting a yellow coloured patch of necrosis at its free edge.

Kidneys:—free from any naked eye change.

C[1]. Guinea-pig inoculated with material obtained from an enlarged inguinal gland in case B[1].

This guinea-pig lived for 98 days.

Post-mortem, the abdominal cavity found full of fluid blood from the ruptured spleen. The inguinal glands at the seat of inoculation enlarged and caseous. The *lungs* studded thickly over with tubercular nodules. *Liver*, undergoing extensive necrotic change at the free edges, the necrotic portions being deeply stained with bile.

Spleen:— considerably increased in size, being 25 times the weight of the normal organ.

Kidneys:—pale, and showing no deposit of any kind in them.

D[1] Two guinea-pigs were inoculated with caseous matter obtained from a caseous inguinal gland of guinea-pig (C[1]).

D[1], (*a*.) died in 60 days, and showed well marked disease at the autopsy.

D^1 (*b*.) died in 103 days, and requires further mention. The abdominal cavity contained one ounce of a blood-stained fluid. The *lungs* were dotted with tubercular nodules over the entire surfaces. The *liver* presented extensive marbling or patchy necrosis, whilst the *spleen* weighed 30 grammes, or 75 times the weight of this organ in a healthy full grown guinea-pig (Figs. 5 and 6).

Experiment II.

Two large glands were removed from the cervical region of a girl aged 11 years; the patient appeared to be in good health, and was well nourished, but rather pale. The glands were thought to be the result of early Hodgkins' disease, but after removal were found on section to have caseous points in their centre.

On section these glands presented the usual appearance found in scrofulous affections, and contained a few bacilli, and numerous giant cells.

A^2 guinea-pig was inoculated with a small piece of the caseous portion of one gland.

The animal died in 293 days.

Post-mortem :—Both pleural cavities filled with fluid; the *lungs* much compressed, but containing some tubercular nodules. The peritoneal cavity also distended with a clear, colourless fluid.

The *liver* :—extensively diseased, both lobes being equally involved.

The *spleen* :—enlarged to six times its normal dimensions, and also the seat of advanced necrotic changes.

B^2 guinea-pig was inoculated with caseous matter from the enlarged caseous inguinal glands of A^2.

This animal died at the expiration of 162 days.

Post-mortem :—Only few tubercles in the *lungs* comparatively speaking, but the bronchial glands enlarged and caseous.

The *liver* :—only slightly diseased, presenting but few grey tubercles on its surface.

The *spleen* :—enlarged four times the normal dimensions, and presenting several large tubercular nodules on its surface. The inguinal glands enlarged at the seat of inoculation.

C^2. Three guinea-pigs were inoculated with caseous matter from B^2.

C^2 (*a*) died in the course of 59 days, with well marked disease in the organs, with the exception of the kidneys. Spleen four times normal size.

C^2 (*b*) died after 65 days with well marked tubercular disease. Spleen four times normal size.

C^2 (*c*) died after 118 days. This animal's life was prolonged owing to the fact that the enlarged inguinal gland suppurated when the system was only feebly infected. Spleen five times normal size.

D^2 guinea-pig was inoculated with the caseous material from inguinal gland of a C^2 guinea-pig.

This animal succumbed with well marked disease of the organs, with the exception of the kidneys, after a period of 64 days.

Experiment III.

In this the third series, the material was obtained from scrofulous abscesses in a boy. These on being opened were found to contain a caseous pulpy material.

On microscopical examination of this material, after staining for tubercle, a few rods coloured red were found, resembling in shape and length tubercle bacilli.

A^3 guinea-pig was inoculated in the inguinal region, with a piece of the above material.

This animal died in 159 days.

Post-mortem :—Enlarged glands containing caseous material were found just above the seat of inoculation. The lungs, liver, and spleen presented an advanced state of tubercular disease, the spleen being six times larger than normal.

B^3 guinea-pig was inoculated with the caseous gland material from A^3. It died in 108 days.

There was, on post-mortem, about one ounce of clear and colourless fluid in the peritoneal cavity, and its organs were the seat of advanced tuberculosis.

C^3. Three guinea-pigs were inoculated from B^3. They died at the following periods after inoculation with advanced tubercular disease of all organs, excepting the kidney :—

a. After lapse of 52 days.
b. „ „ 54 „
c. „ „ 74 „

D^3. Three guinea-pigs were inoculated from caseous material from a C^3 guinea-pig, and all died in about the same period, viz., 35 days. Notes on them read as follows :—

The autopsies reveal much the same changes in each of these animals. Their bodies are limp and poorly nourished. There are several caseous glands just above the seat of inoculation, of the size of a Spanish nut, also several smaller ones in the opposite inguinal region ; in one case there is a large chain of glands, eight in number, running down the posterior surface of the sternum between the two internal mammary arteries, and there is one gland lying externally on the tip of the ensiform cartilage. The pleural cavities each contain about a drachm of a clear, blood-stained fluid. The *lungs* are of a dark red colour, and present several large sized tubercles on their surfaces. The *liver* is dotted all over its surface, and its substance is found on section infiltrated, with small yellow tubercles the size of a pin's head. The *kidneys* are congested, but exhibit no tubercles either on their surface or on section. The *spleen* is enlarged to four times its normal size, and the surface presents numerous yellow coloured nodules, which on section are found to penetrate some distance into its substance. Of one animal, the medulla of both the femurs was found to contain caseous tubercles along with tubercle bacilli.

In reference to the foregoing cases, some of the most important facts are the more readily apprehended when set out in a tabular form : thus the experimental animals, in,—

Experiment I.—	A^1	died after lapse of	-	-	167	days.
„	B^1	„	-	-	123	„
„	C^1	„	-	-	98	„
„	D^1	„	(average)	-	81·5	„
Experiment II.—	A^2	„		-	293	„
„	B^2	„	-	-	162	„
„	C^2	$\left\{\begin{matrix}(a)\\(b)\\(c)\end{matrix}\right.\left\{\begin{matrix}59\\65\\118\end{matrix}\right\}=\frac{242}{3}$	average of		80·6	„
„	D^2	died after lapse of	-	-	64	„

Experiment III.—A^3 „ „ - - - 159 days.
„ B^3 „ „ - - - 108 „
„ C^3 $\left\{\begin{matrix}(a)\\(b)\\(c)\end{matrix}\right\}\left\{\begin{matrix}52\\54\\74\end{matrix}\right\}=\frac{180}{3}$ average of - 60 „
„ D^3 $\left\{\begin{matrix}(a)\\(b)\\(c)\end{matrix}\right\}\left\{\begin{matrix}35\\35\\35\end{matrix}\right\}=\frac{105}{3}$ „ - 35 „

So that in each series, each successive animal inoculated succumbed in a shorter period than that immediately preceding it, viz. the animal from which the material for its inoculation was taken.

By adding together the figures for all A's, all B's, all C's, and all D's, we get totals as to duration of induced malady as follows:—

	A's.	B's.	C's.	D's.
Experiment	I.—167	123	98	81·5
„	II.—293	162	80·6	64
„	III.—159	108	60	35
Totals in days -	619	393	238·6	180·5

And dividing each total by 3, we obtain the average number of days the induced disease took to run its course in each several remove from its original source, viz.:—

A's.	B's.	C's.	D's.
206·3	131	79·5	60·1

Accordingly the difference of duration of the induced malady in,—
B's in comparison with the A's was 75·3 days.
C's „ „ B's „ 51·4 „
D's „ „ C's „ 19·3 „

And similarly A being taken as a constant 100, the duration of the induced malady was,—
In A's - - - 100 days.
„ B's - - - 63 „
„ C's - - - 38 „
„ D's - - - 29 „

Microscopic Examination of the internal Organs of the A series of Guinea-pigs.

On microscopic examination of stained sections, there are seen in the *lungs* disseminated nodular growths irregular in shape, but with well-defined outline. They are generally scattered through the tissue, some near the surface of the organ, and others deeper in its substance.

These nodules in some of the animals are found to consist of the alveolar cavities distended with cells agglutinated together; in others the nodules contain also multi-nucleated or giant cells lying in accumulations of epithelial cells, within the alveoli. In the lungs of the earlier (and longest lived) animals having giant cells in their nodules, such nodules present at advanced stages of the pathological process a caseous degeneration of their central portion; for that portion of the tubercle which was first formed is most remote from the blood supply, and is therefore the first to undergo degeneration. But in the later members of each series, death more quickly followed inoculation, and occurred therefore before this stage had been reached. The epithelial cells filling the alveoli, especially in and surrounding many of these miliary tubercles, are distended by pigment granules deposited in them. Other

parts of the sections show patches of catarrhal pneumonia, with thickening of the alveolar walls.

We know from previous experiments on guinea-pigs with the virus of human tubercle that in naturally acquired tuberculosis (as for instance that due to the animal having inhaled into its lungs the particulate material of the disease), the tubercle bacillus is always present in great numbers in the caseous matter within the pulmonary alveoli (Fig. 2): and that in the artificially induced disease (*i.e.*, where the guinea-pig is subcutaneously inoculated with human tubercular material), the miliary form is generally found, with a very slight distribution of the bacilli in question: in some cases indeed it is exceedingly difficult to demonstrate their presence at all. So too with the guinea-pigs now in question.

In the lungs of the animals of the first experiment, A^1, B^1, and C^1:—

A^1 presented collections of cells agglutinated at the seat of the nodules, but no caseation was noticeable in the patches, and no bacilli were present in any of the sections examined.

In B^1 only a few bacilli were found in the sections of lung, scattered about and at long distances apart; two giant cells contained one bacillus in each cell.

In C^1 and D^1 likewise there were only a few scattered through the sections. They were all double stained and required the use of one-fifteenth Hom. immersion in order to recognise them.

In Experiments II. and III., A^2, A^3, &c., the same difficulty was met with in demonstrating the presence of tubercle bacilli.

The *liver* in each member of the three experiments presented changes due to a miliary tuberculosis, with little or no cirrhosis of the organ; but in those animals which had survived the longest the tubercular nodules were more extensive and contained the most giant cells, although in all the animals the bacilli were very limited in number, or were entirely absent.

The *spleen* in several cases attained a very large size, and its structure was mostly made up of the yellowish-coloured portion which had undergone the "coagulation-necrose" process. In the tissue thus affected no bacilli were found, but at the junction of this and the normal spleen bacilli were found, though few in number.

Series B.—Experiments with Lupus.

During the past six years I have had opportunity of examining excised portions and scrapings from 10 cases of lupus. In seven of these, viz., those in which the portions obtained were sufficiently large to make sections, I have always been able (after staining the sections by the usual methods) to demonstrate the presence of the tubercle-bacillus; but very often I have had to examine many sections before being able to find even one of the bacilli in question. I may here mention that in two cases of tubercular disease of the skin also I have made preparations and examined for the tubercle bacillus. As a result I can fully bear out the statement of Schwimmer that in this form of the disease the tubercle-bacilli are far more numerous than in lupus, as numerous almost as in the sputum in a well-marked case of tubercular phthisis.

I should mention, in regard to the 10 cases which appeared to be lupus, that a guinea-pig inoculated with matter of one of the above specimens succumbed to a well-marked general tuberculosis in a period of 128 days, and I thus obtained a suspicion that the specimen in question ought perhaps to be regarded, not as a case of lupus, but rather

of a case of tuberculosis of the skin; and accordingly I have omitted further reference to that case.

Experiment I.

Two guineas-pigs were inoculated with fresh material obtained from scrapings removed from the face of a patient suffering from lupus vulgaris. On microscopical examination of this material, and after looking through seven sections, I found several bacilli stained red by magenta, two of these bacilli being found in a giant cell.

No. 1 animal died after a period of 191 days.

Post-mortem:—Very minute grey tubercles in the *lungs*, *liver*, and *kidneys*; only discernible with the aid of a magnifying glass.

No. 2 died after a period of 302 days.

Post-mortem:—The body fairly well nourished, no local affection discovered at the seat of inoculation.

The *lungs* just floated in water; the surfaces were mottled over with whitish tubercles. On section they were found to be very tough, and the following conditions were especially noticed.

The cut-surface presents two differently coloured portions:—the one (and greater part) being of a yellowish tinge interspersed with dashes of a greyish-black, and of firm texture; the other pinkish in colour, and having a fine honeycombed appearance. The latter is the healthy portion of the organ, the former is pathologically changed tissue. In addition there are seen certain cavities, varying from one-twentieth to one-sixth of an inch in diameter, entirely occupying the yellowish coloured portion. Some of these are circular, others of irregular outline, being due to the running together of two or more cavities (Fig. 7). The whitish appearance seen on the external surface of the organs is found to have been produced by the thickened and visceral plura, which forms the external boundary to these superficial cavities.

The *liver*, great *omentum*, and *spleen* all presented many projecting grey translucent nodules. The spleen weighed 1·6 grammes as against 0·4 grammes in the normal state.

The *kidneys* also contained several grey tubercles in their cortex, and on section several of the capillary blood vessels appeared to be distended with blood.

Experiment II.

Two guinea-pigs were inoculated with scrapings obtained from the nose and cheek of a patient suffering from lupus vulgaris.

No. 1 died in 221 days.
„ 2 „ „ 257 „

In each case no changes, microscopic or other, in the organs were apparent at the post-mortem.

Experiment III.

Two guinea-pigs were inoculated with material from the face of a patient suffering with lupus vulgaris.

No. 1 died after lapse of 374 days, and the only change observable in it was the presence of a caseous gland at the seat of inoculation.

No. 2 died after lapse of 361 days.

Post-mortem:—An enlarged gland one inch in length occupied a position in the right inguinal region just above the point of inoculation. On section this gland presented numerous caseous foci.

Lungs:—no microscopical changes.

Liver :—the upper surface had a few grey tubercles scattered over it.

Spleen :—enlarged to four times the normal size, and numerous white and yellow nodules projecting from the surface. (Fig. 8.)

Kidneys :—several small miliary tubercles dotted over the cortex.

From No. 2, guinea-pig No. 3 was inoculated, a portion of the caseous inguinal gland being used for the purpose. Within 30 days an enlarged gland could be felt just above the seat of inoculation.

This animal died after a period of 210 days.

Post-mortem :—There was an enlarged gland an inch in length by one third of an inch in width, occupying the right inguinal region.

The *lungs :*—dotted over with tubercular nodules.

The *liver :*—white tubercular nodules in both lobes.

Spleen :—enlarged to five times the normal size; numerous yellow nodules, varying in size from a pin's head to one third of an inch in diameter, and projecting from the surface.

The *kidneys :*—several tubercular nodules on the external surface which (as seen on section) dip a short distance into the cortical substance.

Abdominal glands :—enlarged in the fissure of the liver, behind the stomach, and in the lumbar region. Also some caseous nodules in the mesentery.

In the medulla of the femora, small irregular yellow spots, which on microscopical examination proved to be tubercles in the stage of caseation; tubercle bacilli present in them.*

These experiments on guinea-pigs may be summarised thus :—

I.—No. 1. Died after lapse of 191 days. Very early tubercular disease of the internal organs.

No. 2. Died after lapse of 302 days. Advanced tubercular lesions in all these organs.

II.—No. 1. Died after lapse of 221 days. No microscopic change in these organs.

No. 2. Died after lapse of 257 days. No microscopic change in these organs.

III.—No. 1. Died after lapse of 374 days. Small caseous gland at seat of inoculation.

No. 2. Died after lapse of 361 days. Large inguinal gland, tubercular lesions in the liver, spleen, and kidneys.

No. 3.† Died after lapse of 210 days. Large inguinal gland, tubercular lesions in the liver, spleen, lungs, and kidneys.

Adding together 302 and 361 days, the duration of life of the two animals (No. 2, Experiment I., and No. 2, Experiment III.) which died with pronounced general tuberculosis, we get for guinea-pigs 331·5 days as the average duration of tuberculosis induced by direct inoculation of lupus material. Now tuberculosis in guinea-pigs induced by inoculation of virulent tubercular matter causes death in, on an average, 80 days only: So that with these animals inoculated lupus takes four times as long as inoculated tubercle to produce general tuberculosis.

Microscopical Examination of the Organs of B. Series of Guinea-Pigs.

The *lungs* in incipient cases show one or more miliary tubercles in each section. These tubercles are found to consist of epithelial elements,

* On the Etiology and Pathology of Tuberculosis, by Dr. Klein, F.R.S., and Mr. A. Lingard.

Report for 1886 of the Medical Officer of the Local Government Board.

† This case in that it was inoculated with material which had been passed from the human subject to the guinea-pig, corresponds to the B animals of Series A.

and small round cells resembling leucocytes, occupying the alveolar cavities. Several bacilli were seen, never exceeding 10 in number, scattered through the mass irregularly. At a later date, when the whole nodule has become more or less caseous, one is unable to recognise the presence of bacilli in the centre of the patch, but on directing one's attention to the periphery several are to be observed. Here again the bacilli are only seen singly and in pairs, frequently lying parallel to each other.

In more advanced disease, one finds on section of the lung that it has been completely transformed into a series of large cavities communicating with the bronchi. These cavities are lined with a narrow zone of small round cells lying in an opaque and granular matrix (probably pus cells) upon a layer of white fibrous tissue, the fibres of which run parallel to the surface of the cavity. In this cellular layer several isolated bacilli are observable scattered about and lying at some distance apart. Other portions of the section show thickening of the alveolar septa, with large numbers of small round cells lying between the meshes of the connective tissue, while the bronchi and blood-vessels are surrounded by bands of fibrous tissue of varying thickness. The cells inside the alveoli are pressed together in consequence of the thickening and contraction of the alveolar walls.

In the *liver* the first changes are observed in the interlobular connective tissue; this becomes increased in amount and embryonic in character, and in more advanced cases the liver lobule becomes an island, entirely surrounded by this new growth of cells. It is in this tissue that the tubercle first starts, encapsuled by proliferated cells; but it may be seen also in the liver-cell islands, and there the tubercle always has a zone of proliferating cells round it. This interlobular tissue, increasing as the disease advances, is finally converted into fibrous tissue, and coincident with these changes a proliferation of cells has been in progress in some parts between individual liver cells, the result being that on the death of the animal nearly two-thirds, in extreme cases, of the whole organ are fibrous in character, while that which remains of the original structure has undergone more or less atrophy from the pressure exerted by this intercellular proliferation.

The above change in the liver, it will be observed, is nothing more than a final cirrhosis of the organ commencing as an interstitial hepatitis. The tubercles which are formed in the new interlobular growth, consist of exactly the same elements as those found in the lungs and spleen, viz., small round cells, while at a later date giant cells are found in the centre of the nodule. The vascular supply becomes cut off from it, and caseation starts from the centre and spreads to the periphery. In these nodules in the liver the same paucity of bacilli is observed as in the lung; two or three in each section is all I have noticed, while at a later date I have examined many sections without being able to recognise the presence of a single one.

In the *spleen*, however, where the same changes take place as above described, one frequently observes in the same section large numbers, relatively speaking, of bacilli; here they may be seen in the giant cells in the centre of the nodules, but rarely more than two together, although in one instance I found as many as five in the same cell. They may be seen also singly lying between the small round cells, and often in pairs parallel to each other. In the nodules undergoing caseation they are also present, but are not so numerous as before that process has commenced. (Figs. 8, 9.)

In the *kidneys* I have noticed the presence of miliary tubercles scattered through the cortical portion in three animals which, after inoculation with lupus, died in 191, 302, and 361 days respectively. All

the changes noticeable, and certainly the gross lesions, are in the cortical substance. There is considerable engorgement and distension of the blood-vessels, both in the primary trunks running up between the uriniferous tubes as also in the peripheral capillaries. Most of the Malpighian corpuscles appear to have undergone some hyaline change, the portions affected being colourless and transparent. The more recent tubercles present the usual small cell infiltration, with one or more giant cells in the centre of the mass, and the bacilli dotted about in their midst. In a particular instance one very large giant cell, which contains three bacilli, is situated very close to the cortical border of the organ. In patches undergoing caseation one is unable to make out any very definite structure, but here again we find the bacilli present, though always in relatively small numbers.

For convenience of reference, I here introduce in tabular form comparison of the results of inoculation into guinea-pigs of material of tubercle, of scrofula, and of lupus.

Table showing the Results of Inoculation of Guinea-Pigs with Tubercle, with Scrofula, and with Lupus.

—	Tubercle.	Scrofula.	Lupus.
Subcutaneous inoculation of material.	Followed in the course of 6 or 7 days by appearance of enlargement of glands, just above the seat of inoculation.	Enlargement of glands noticed in two to three weeks.	Enlargement of glands in four to five weeks; 28 days the earliest date noticed.
Average duration of guinea-pig's life after inoculation.	About 80 days - -	206·3 days - -	331·5 days.
Sections of *lung* stained in magenta and decolourised in 33 % nitric acid.	Presence of miliary tubercle, made up of round cells with giant cells in the centre of the nodule; bacilli singly or in clumps or nests, but varying greatly in number in different cases.	Ditto; bacilli few in number.	Ditto; bacilli very few in number.
Lungs in advanced cases of disease.	Sections show numerous nodules undergoing caseation.	Ditto - - -	Ditto.
Cavities in the *lungs*.	Never observed, the pathological process being too rapid.	In two cases, cavities observed: — in one only very few; in the other, which died after 188 days, cavities numerous.	Lungs riddled with cavities in communication with the bronchi.
Liver (size) -	Considerable hypertrophy.	Ditto - - -	Hypertrophy less marked.
Changes in the *liver* tissue.	Few grey disseminated nodules are formed; then lighter patches which increase in size and run together, become rather a deep yellow. The liver meanwhile increases enormously in size, and becomes marbled with large tracts of yellow and brown. In the darker parts of the organ recent grey tubercles are generally seen.	Ditto - - -	Early changes; commencing interstitial hepatitis, with deposition of tubercles in the interlobular connective tissue and also in the intercellular tissue of the lobules. Coincident with this, fatty infiltration of the liver cells is taking place, and at a later date caseous degeneration of the tubercular nodules occurs; and finally the organ becomes the seat of an advanced cirrhosis.

——	Tubercle.	Scrofula.	Lupus.
Spleen - -	Considerable hypertrophy.	May attain enormous proportions. In one case the organ was found to weigh 75 times the normal weight.	Hypertrophy, but never more than from 8 to 10 times normal weight.
Tissue changes of *spleen.*	The organs present a dark red colour, from which the nodules stand out very clearly. The tubercles become confluent, and large greyish-white islands result. These increase in size so that the spleen acquires a marbled appearance. Finally the appearance of the organ does not recall the tuberculous origin of this condition.	Ditto - - -	The animal does not attain this stage of the disease; it usually succumbs with the nodular condition of the organ present.
Micropathology of *spleen.*	In the early stage of this disease bacilli are observed free in the nodules and also in the giant cells; at a later date the bacilli are found scattered about the line of demarcation between the red substance and the yellow "coagulation-necrose."	Ditto - - -	Ditto.
Kidneys.—Miliary tubercles.	No miliary tubercles have been observed in the inoculated guinea-pig.	In one case—death occurring on the 188th day—some five or six were observed in each kidney; they contained giant cells and bacilli; caseation present in several nodules.	Several generally observed, containing bacilli and giant cells—in one case four or five bacilli in a giant-cell—also a nest of bacilli in a small capillary vessel. (Fig. 10.)
The bacillus -	In length from a quarter to half the diameter of a red blood corpuscle. ·0015—·0035 m.m.	Ditto - - -	Ditto.
The medulla of *bones.*	The medulla of the femora contains caseating tubercles.	Ditto - - -	Ditto.

The facts as to "tubercle," in the columns of the above table, are derived from the experience of many observers.

In this connexion the reader is invited to recall the various experiments made with tubercle from human and from bovine sources, on animals of one and another kind, and recorded in previous reports of this series.

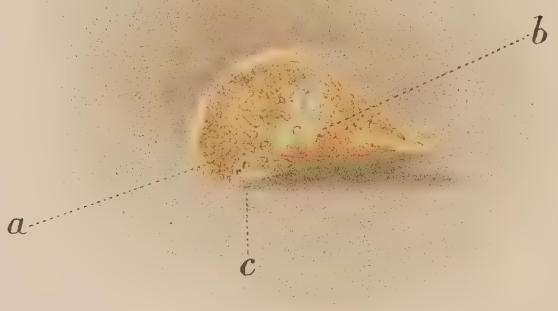


FIG. I.

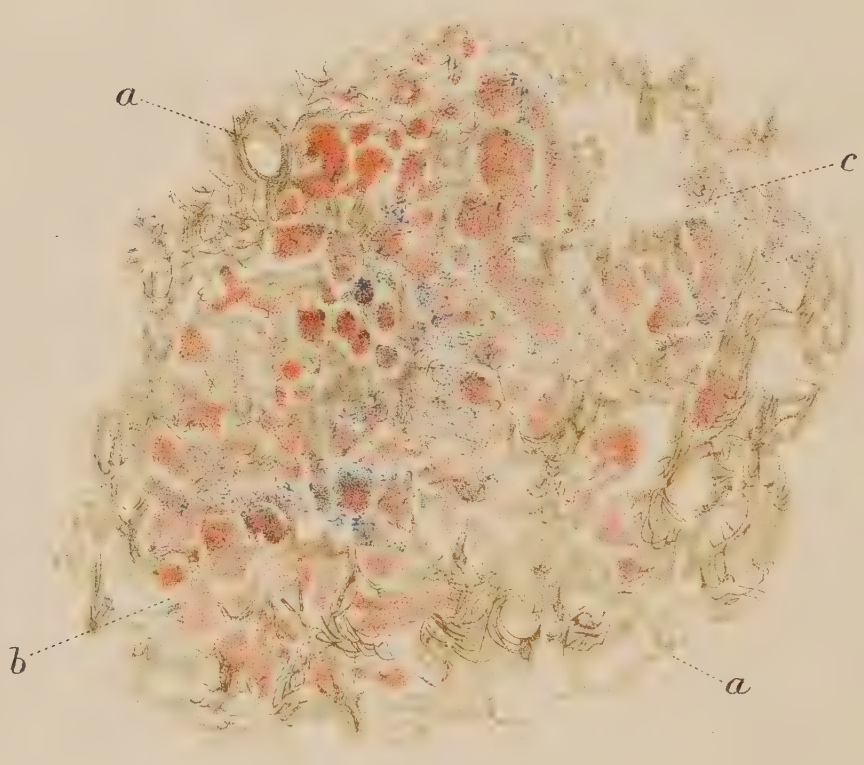


FIG. II.

M. H. Lapidge, del.

Dansfield, Lithographer, London. 1873.

SCROFULA.

FIG. I.

Section of a lung of a guinea-pig (C^1, Experiment I., Series A.) that died on the ninety-eighth day, after inoculation with scrofulous material derived from a caseous cervical gland (human).

[Natural size.

a. Healthy lung tissue.
b. Fibrous change.
c. Cavities formed by the breaking down of tubercular nodules.

FIG. II.

Transverse section through the lung of a guinea-pig the subject of spontaneous scrofulous broncho-pneumonia.

[Magnifying power × 45.]

a. Lung tissue.
b. A colony of bacilli stained red.
c. The nuclei of the cells stained blue.

The preparation from which this drawing was made was stained first in magenta (Weigert), afterwards submitted to a 33 per cent. solution of nitric acid, and counter-stained with methyline blue.

SCROFULA.

Fig. III.

Represents a small portion of the lung shown in Fig. II., more highly magnified.

[Magnifying power × 1,100.]

a. Bacilli stained red.

b. Alveolar wall of lung.

Fig. IV.

Four cells from a tubercular nodule in the liver of a guinea-pig inoculated with scrofulous material.

[Magnifying power × 1,100.]

Nuclei of cells stained a bluish colour.

Bacilli stained red.



FIG. III.



FIG. IV.



FIG. V.

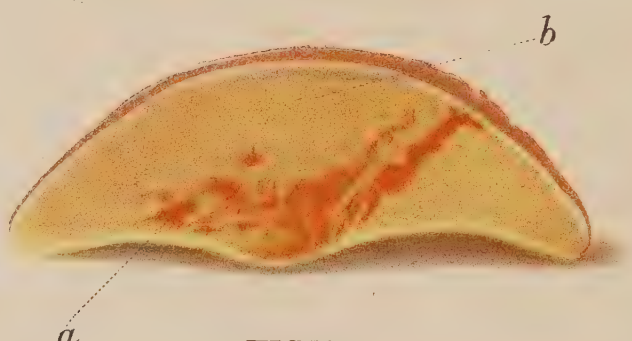


FIG. VI.

SCROFULA.

Fig. V.

Convex surface of the spleen of a guinea-pig (D^1 (b), Experiment I., Series A.) inoculated with scrofulous caseous matter obtained from an inguinal gland of guinea-pig C^1, Experiment I.

This spleen was seventy-five times the weight of that of a healthy full-grown guinea-pig's.

[The drawing shows this spleen natural size.]

a. Extravasations of blood under the capsule.

b. Yellow patches undergone coagulation-necrose.

Fig. VI.

Transverse section of the same spleen as is represented in preceding figure.

[Again natural size.]

a. Normal tissue of spleen coloured red.

b. Parts which have undergone necrosis.

LUPUS.

Fig. VII.

Sections of the lungs of a guinea-pig (No. 2, Experiment I., Series B.) that died on the three hundred and second day, after inoculation with material obtained from a case of lupus vulgaris of the face.

[Natural size.]

a. Healthy lung tissue.
b. Fibroid change.
c. Cavities formed by the breaking down of tubercular nodules.
d. Deposits of pigment.

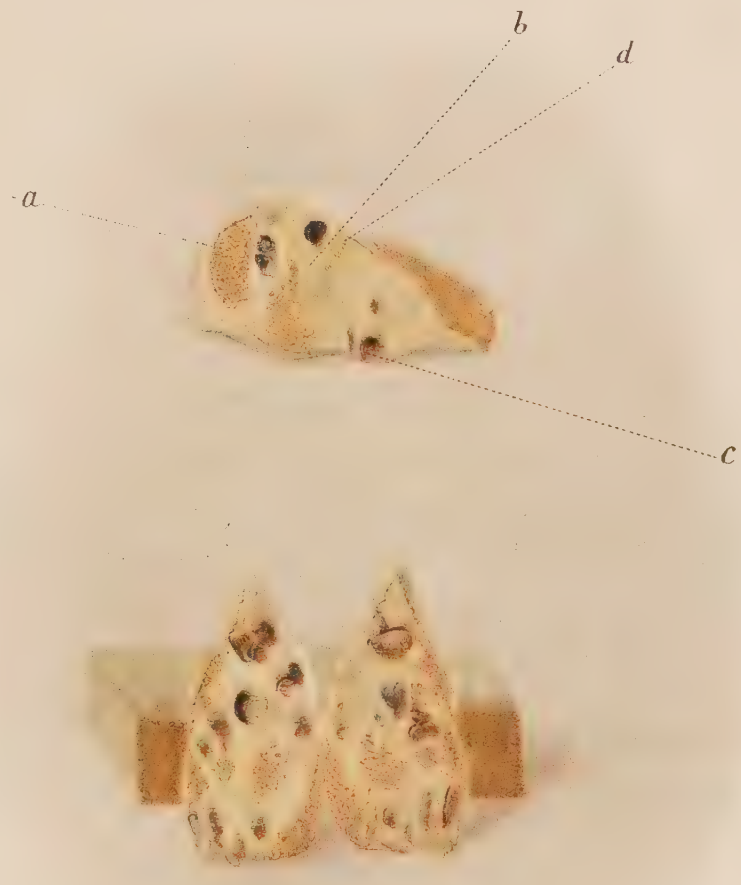


FIG. VII.

M. H. Lapidge, del. Dangerfield, Lithographer, London. 1873.2

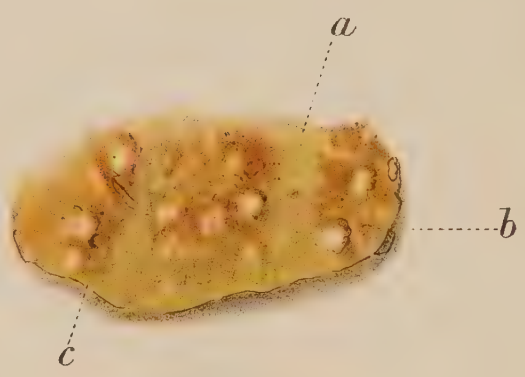


FIG. VIII.



FIG. IX.

LUPUS.

Fig. VIII.

Spleen of a guinea-pig (No. 2, Experiment III., Series B.) which died three hundred and sixty-one days after inoculation with material from the face of a patient suffering with lupus vulgaris.

[Natural size.]

a. Tissue of spleen which has become necrosed.

b. A tubercle yellow in colour, raised at least $\frac{1}{12}$th of an inch above the surrounding tissue.

c. Extravasated blood, coloured red, round the bases of the tubercles.

Fig. IX.

Section of same spleen stained with magenta, and submitted to 33 per cent. nitric acid, and then counter-stained with methyline blue.

a. A giant cell containing numerous nuclei stained blue, and two bacilli stained red.

b. Nuclei of ordinary splenic cells.

c. Bacilli stained red, arranged in pairs.

LUPUS.

Fig. X.

Section of a kidney of a guinea-pig inoculated with lupoid material from a case of lupus vulgaris.

[Magnifying power × 1,100.]

a. Cross section of a urinary tubule.

b. A colony of bacilli stained red, in a tubule cut longitudinally.

Fig. XI.

A group of tubercle-bacilli obtained from tubercular sputum for comparison with the above.

[Magnifying power × 1,100.]



FIG. X.



FIG. XI.

No. 6.

Report on the Chemical Changes produced by Bacteria in Albumens and Peptones; by Dr. A. Macfadyen.

I.

Synopsis of our present Knowledge with regard to the *Chemical Changes produced by Bacteria.*

Biology of morbid bacteria.

The causal relation of micro-organisms to specific diseases and morbid processes in man and the lower animals has rendered the study of the biology of these microbes of the highest importance to medicine.

Chemical changes effected by bacteria.

The methods of Koch have enabled us to isolate in pure cultures pathogenic micro-organisms outside the body, and to study them as living individuals. The mere mechanical action of these microbes is not sufficient to account for the pathological results which arise from their presence or multiplication within the body. The bacteria are living cells, and endowed with functions whereby they exert more or less marked reaction on their environment. We have therefore to ask ourselves by the exercise of what vital function is it that such cells are able to produce disease? Is it a direct result, a problem in nutrition, or is it an indirect result arising from perverted metabolism? The capacity for inducing chemical change is a marked characteristic of micro-organisms; thus, for example, by helping to bring about the phenomena of putrefaction, they play an important rôle in the economy of nature.

Many of the symptoms of infectious disease are so eminently toxic in character that it is quite a feasible hypothesis to suppose that such symptoms are due to some chemical product of the bacteria. This idea, rapidly gaining ground, has given to research a new direction. The methods of isolation in pure cultures, which rendered possible a more exact study of the morphology of bacteria, have also given us a means whereby we may study their physiology, and the effects produced by them on the soil upon which they have grown. We are accordingly in a position to investigate the results of the metabolism of bacteria; what are the products of their life processes, and what the effects of these products on living matter. It is necessary for medical science to learn all that can be learned concerning the biology of microbes, in tracing their relations to disease, and to take note of all facts, even of those that might seem of interest solely to the biologist or to the chemist.

Biology and chemistry to be studied together.

The study of the products of bacteria is a subject as yet in its infancy, and two causes have hitherto retarded its progress. The chemist as such has in his investigations used exact chemical methods, but has not usually been sufficiently acquainted with bacteriology to make isolation in pure culture a *sine quâ non*. Thus we cannot be sure that his results are due to the organism with which he believes himself to have been dealing, or to more than one organism, through accidental contamination of his cultures.

On the other hand, the biologist, while securing isolation of his micro-organism in pure culture, has not generally been able to give to his results the necessary chemical precision. Still, our present knowledge is sufficient to lead us to expect from chemical research a deeper insight into disease processes: and meanwhile the achievements that are being made in the department of organic chemistry are doing much to aid its advance.

But discoveries in organic chemistry will not, as some suppose, render a bacterial theory of disease less tenable. They will but deepen the problem, by showing that disease is induced in a more complex fashion than we had supposed, and that hitherto unsuspected factors, connected with the biology of microbes, are concerned in its production.

It is not possible to arrive at the rationale of any phenomenon without appeal to one or other of the exact sciences, as for instance, physics or chemistry, and the problems of medicine to-day are largely chemical ones. Twelve chemical elements* enter into the constitution of all living things, and it is their compounds that are primarily affected in disease processes. Every change, therefore, in the human body should, so far as we are able, be made a subject for physiological or pathological chemical investigation.

The capacity of the bacteria to produce pathological change renders the study of their metabolism of fundamental importance to medicine.

Metabolic products: their concern in medicine.

The metabolic products of bacterial life have, for instance, concern with medicine in a variety of ways. These products:—

1. React on the microbe that produces them.
2. Act also on other microbes.

Better knowledge of them:—

3. May afford diagnostic points of value.
4. May throw light on the complex structure of the bodies that the bacteria are capable of disintegrating.
5. May help to illustrate the physiological chemistry of the animal body.
6. May help to explain morbid processes in the digestive tract, *e.g.*, the diarrhœal affections of children and fermentative changes within the body of food stuffs,—and thus supply hints of therapeutic value.
7. May explain the virulence of certain bacteria which are highly toxic.

Investigation of these products is therefore necessary for:—

8. Obtaining a better knowledge of acquired immunity.
9. Apprehending the concern for medical jurisprudence of the nitrogenous bases produced by bacteria.
10. Getting to know what may be the concern of bacteria in the manufacture, outside the animal body, of deleterious matters causing so-called "food-poisoning."

Classified actions attempted.

Frankland† divides the chemical actions induced by living organisms into two kinds—

1. Synthetical, chiefly performed by plants.
2. Analytical, chiefly performed by animals.

The micro-organisms would be included in the second class, *i.e.*, analytical.

Formerly a hard-and-fast line was drawn between micro-organisms and plants (Algæ), based on the following grounds. Whilst the latter are able to assimilate carbon and nitrogen from simple bodies such as ammonia and carbonic acid, the former, lacking chlorophyll, are not so endowed, and require for their nutriment organic bodies. The microbes break up dead organic matter (animal and vegetable) into the simpler

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* Carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, lime, chlorine, sodium, magnesium, iron.

† Journal of Chem. Society. 1885.

compounds which the higher chlorophyll plants are alone able to assimilate. On this view micro-organisms were intermediaries helping on the perpetual circulation of matter.

Pasteur,* however, has proved that the torula, like the higher plants, is able to assimilate carbon and nitrogen from *some* inorganic bodies, *e.g.*, the ammonia salts. And Hueppe† announces the discovery that a bacterium containing no chlorophyll can assimilate carbon from carbonic acid. In England, Dupré for the Local Government Board and many chemical investigators for the Royal Agricultural Society have investigated the oxydizing and reducing agency of bacteria under a number of conditions. We now know that the conditions under which micro-organisms can grow are capable of greater variation than was at first supposed, and that many of them show an adaptiveness to such variations. Further, we know that microbes differ in their biological peculiarities, and that, under varying external conditions, will manufacture different chemical products. Finally, that certain classes of the bacteria, like plants, are able to extend their assimilative power by means of ferments.

We are no longer, therefore, able to accept the generalisations sufficing in the earlier days of bacteriological research; generalisations which took account mainly of physiological function, differentiating it on the basis of the significance then hypothetically attached to chlorophyll. Such formulæ had their use in bringing out the broad functional distinctions that exist between organisms that are plants and organisms that are animals. But we must avoid introducing them into the study of bacteriology, where in the matter of function class differs from class and even individual from individual, and one and the same bacterium may be capable of bringing about the most versatile chemical changes.

Recognition of each kind of bacteria is essential.

In illustration of the above remarks we may note that certain microbes induce special fermentations, *e.g.*, the lactic and butyric. Others liquefy gelatine, and an important group are concerned in the phenomena of putrefaction. Many only exert their special activity in the presence of oxygen, and are pre-eminently aerobic; others are pre-eminently anaerobic, whilst a number can exist aerobically and anaerobically. Variations of temperature conditions also affect micro-organisms very differently; some, like the bacillus tuberculosis, being most sensitive to changes. For each bacterium, a certain temperature is necessary for full activity, and if this optimum be exceeded the bacterium may become "attenuated." Finally, the nature of the soil may be a most important factor; thus the pathogenic bacteria flourish only in rich proteid soil, whereas certain water bacteria are capable of reproduction even in sterile distilled water.‡

Accordingly each microbe must be studied *per se*. Generalisations with regard to the biology of micro-organisms are not yet possible.

For the complete study of a microbe the following points must be investigated:—

1. Morphology.
2. The conditions under which it can live and reproduce itself; *i.e.*, the influence on it of environment.
3. Biology:
   (*a.*) Assimilation;
   (*b.*) Metabolism.

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* Annales de Chimie et de Physique. Vol. 58.
† Die Methoden der Bakterien-Forschung. 1889, p. 9.
‡ Bolton. Zeitschrift fur Hygiene. Vol. I.

4. Hygienic significance :

a. Ferment action ;

b. Pathogenic action.

Before passing to the particular subject matter of this paper,—the metabolic products of bacteria,—it will be necessary to dwell on some general considerations connected with the biology, viz., nutrition and assimilation.

Nutrition.

Cultivations.

The earliest method of artificially cultivating microbes was by means of Pasteur's fluid, which had the following composition :—

Ammonium tartrate - - -	1 part.
Candy sugar - - - -	10 parts.
Yeast ash - - - -	1 part.
Water - - - - -	100 parts.

Its composition was based on a study of the properties of *yeast*. Pasteur* found that the yeast could take nitrogen from ammonia compounds ; oxygen and hydrogen from water. The potassium, phosphoric acid and sulphur were supplied by the yeast ash. The yeast not being able to assimilate carbonic acid, sugar was added as the source of carbon.

Bucholtz† came to the conclusion that *bacteria* do not require albuminates. They will grow if supplied with nitrogen in an ammonia salt ; and with carbon in sugar, tartaric or citric acid. The important constituent of the ash is phosphoric acid. He replaced the yeast ash by 0·5 gramme potassic phosphate.

Cohn‡ applied Pasteur's results with yeast to the bacterium termo. He found that sugar was superfluous, and that carbon could be supplied by organic acids, *e.g.*, tartaric.

Accordingly Cohn left out sugar, and replaced the yeast ash by certain salts, which he found necessary for the bacteria. His fluid was constituted as follows :—

Potassium phosphate, 0·1 grm. ; magnesium sulphate, 0·1 grm. ; tribasic calcium phosphate, 0·01 grm. ; distilled water, 20 grms. ; ammonium tartrate, 0·2 grm.

The more recent researches of Nägeli§ led to still further modifications. He recommends three normal fluids, viz. :—

No. 1, fluid—consisting of water, 100 C.C. ; ammonium tartrate, 1 grm. ; dipotassic phosphate, 0·1 ; magnesic sulphate, ·02 ; and calcic chloride, ·01 grm.

No. 2, fluid—which has the composition of No. 1, except that ammonium tartrate is replaced by albumen peptones.

No. 3, fluid—which also contains the constituents of No. 1, but in addition cane sugar.

By the addition of sugar and acids the solutions can be used for cultivation of mould fungi and yeasts.

None of these fluids can be regarded as suitable culture media for all or any bacteria. The pathogenic bacteria require for their growth albumens and peptones. Pasteur devised a chicken broth, and French workers still use to a great extent such liquid infusions.

Koch, by the introduction of solid transparent media, advanced the technique to a higher degree of perfection. By their means the purity

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* *l.c.*, page 3.

† Archiv. für exper. Pathol. 1877.

‡ Beiträge zur biologie der Pflanzen I.

§ *l.c.*, page 3.

of cultures can be more exactly controlled, and the morphological peculiarities of bacteria more fully brought to light. The following may be taken as a type :—

To meat infusion add sodic chloride ·5 per cent.; peptone 1 per cent.; gelatine 5–10 per cent., and neutralise with soda solution.

Dealing now with particular classes of organisms :—

Classes of organisms.

Mould-fungi.

1. *The Mould Fungi.*—Chemical analysis shows that in them the non-nitrogenous organic matter, in the form of cellulose, exceeds the nitrogenous organic matter, and that albuminous bodies are found only in the cell contents. It shows also that they contain a certain proportion of sugar-like bodies. Of inorganic constituents, besides water, potassium and phosphoric acid are the most important.

Roughly, no complete analysis having as yet been effected, the proportions are as follows (Flügge) :—

Water - - -	88 per cent.
Nitrogenous matter -	3 „
Non-nitrogenous matter -	5 „
Ash - - -	1 „

Nägeli* states that the *nitrogen* is best assimilated from soluble proteid bodies and peptones, but that it can also be taken from nitrates and ammonia salts.

The *carbon* is best assimilated from soluble and easily decomposed carbohydrates, *e.g.*, the sugars. *Sulphur* is an important constituent in the mould fungi, and is readily assimilated from sulphates and sulphites. Whilst *water* is necessary, the mould fungi will still grow in mixtures, which through desiccation have become unsuitable for the yeast fungi (saccharomycetes) and the schizomycetes. Therefore where there is very little water, the mould fungi get the start of and outgrow bacteria. This explains the appearance of moulds in old and dried cultures of bacteria. As regards *mineral* substances there must always be simultaneously present a salt of an alkali and a salt of an alkaline earth (*e.g.*, potassic phosphate and an earthy phosphate). These investigations of Nägeli supplement the earlier and less exact researches of Pasteur† and Raulin.‡

The mould fungi require free oxygen for their normal growth, which accordingly takes place best on the surface of a fluid. An interesting distinction between them and the schizomycetes is found in the influence of the reaction of the fluid medium in which they are growing. The mould fungi are hindered in their growth by an excess of alkali; the majority of the schizomycetes by an excess of acid. Some of the mould fungi secrete inverting ferments.

Yeast-fungi.

2. *The Yeast Fungi.*—There are no sufficiently accurate chemical analyses that would serve for purposes of comparison. But yeast fungi contain about 37 per cent. cellulose and 47 per cent. proteid matter, thus reversing the relations that exist between the two in the mould fungi (50 per cent. cellulose and 29 per cent. proteid matter). The ash too contains much more phosphoric acid, corresponding to the larger percentage of proteid matter present. The amount of water varies from 40–80 per cent. A peculiar proteid body which enters largely into the composition of the schizomycetes is also found in them. It is called *myco-protein*, and was isolated by Nencki.§ As regards *nitrogen-assi-*

* Untersuchungen über niedere Pilze. Munich, 1882.
† Annales de Chimie et de Physique. Vol. 58.
‡ Compt. rend. T. 56, p. 229.
§ Beiträge zur Biologie der Spaltpilze. 1880.

milation, the conditions are much the same as with the mould fungi, though probably these yeast fungi require more nitrogen, on account of the larger amount of nitrogenous matter they contain. But it must be observed that they undergo degeneration after a time if only nourished on ammonia salts, and that nitrates are not reduced by them.

Carbon is assimilated from the same sources as by the moulds, the best sources being sugar-like carbohydrates; some require special carbon compounds, for example alcohol seems to be indispensable to the mycoderma vini.

The important mineral foods are potassium, calcium, and phosphoric acid.

The yeast fungi can grow *without* free oxygen, if a fermentable body be present, *e.g.* sugar, in virtue of the *ferment* power they possess. This ferment activity is supposed by Nägeli to supply them with the necessary energy they would under ordinary conditions derive from free oxygen. In virtue of this they are able to grow inside fruits containing sugar.

With respect to *reaction*. An excess of alkali is inimical to their growth, and they are not able to withstand so large an excess of acidity as the mould fungi.

The conditions of *temperature* favourable to growth vary greatly for the mould fungi, ranging with different individuals from 10–40° C. For the yeast fungi the optimum temperature seems to lie between 25–30° C., *i.e.*, they are most active between these temperatures.

If the yeast fungi are able to exercise their ferment power in a liquid, they will outgrow and starve any other bacteria that may simultaneously be present.

Ferment power is their marked feature, but it is to be distinguished from their own nutrient metabolism, and to be regarded as superadded thereto.

Schizomycetes.

3. *The schizomycetes.*—Chemical analyses of these organisms again vary greatly, but they tend to show that the cellulose in them is still further diminished, and that the nitrogenous organic matter constitutes nearly the whole of the cell mass. The nitrogenous matter is mostly made up of *myco-protein*, which differs in its reaction from other proteid bodies. It contains no phosphorus and no sulphur.

The constituents of their ash are probably similar to those of the yeast fungi.

Whilst varying greatly, they, it may be said, best assimilate *nitrogen* from diffusible albuminous bodies. According to some observers they can also reduce nitrates. Heraeus* isolated bacteria that can oxidise ammonia to nitric acid, and Hueppe† has found one and the same cell exercising *both* oxidising and reducing properties. *Carbon* is taken from sugars and sugarlike bodies, and even from very dilute carbolic and salicylic acids; the two latter in concentration are *toxic* to the bacteria.

Temperature conditions favourable to schizomycetes vary greatly, but it may be said that the temperature most suitable to them is higher than in the case of the other two classes, *i.e.*, nearer to the conditions obtaining in the animal body.

As regards *reaction* of the culture media, an excess of acidity or alkalinity is injurious, and more especially the former. But there are exceptions, *e.g.*, the bacillus butyricus can grow in a strongly acid medium; the micrococcus ureæ in one strongly alkaline. Finally, some

* Zeitschrift für Hygiene. Vol. I.
† Die methoden der Bakterien Forschung. 1889.

growing in an acid medium change the reaction to alkaline, and then still further develop. As a rule the nutrient solutions for mould fungi are made slightly acid; those for bacteria neutral or faintly alkaline.

As regards their requirement of *oxygen*, the schizomycetes have been divided into three groups :—

Their groups.

i. *Obligatory Anaerobic*, which reach their optimum growth only in the absence of free oxygen; *e.g.*, bacillus butyricus; bacillus of malignant œdema.

ii. *Facultative Anaerobic*, which grow best with a supply of free oxygen, but can also grow in the absence of air, *e.g.*, many pathogenic microbes (Koch's commabacillus, &c.).

iii. *Obligatory Aerobic*, which do not grow in the absence of air, *e.g.*, bacillus subtilis (Liborius*).

The more exact research becomes, the more striking are the differences noted in the biological peculiarities of the schizomycetes. Some are capable of adapting themselves to the most diverse conditions; others are very susceptible to change of conditions, or will grow only on certain culture media. Amongst the most sensitive in this respect are the pathogenic bacteria, often only capable of a parasitic existence in certain animals; they may prove incapable of cultivation on dead matter, or demand a congeries of organic bodies for their nourishment. Other forms, *e.g.*, the saprophytic, are not so sensitive, and grow well on ordinary culture media, whilst amongst the least sensitive must be reckoned the bacteria that are capable of reproduction in pure distilled water. Lastly, mention must be made of those which, by means of ferments, extend their assimilative power, and convert insoluble into soluble bodies.

From these general remarks it will be seen how far we still are from understanding all the conditions of life of the bacteria; and how great the importance of continued study of those of pathogenic significance, especially as regards their effect on soil and *vice versâ*.

Assimilation.

Assimilation.

With respect to assimilation,—in plants containing *chlorophyll*, their carbon is obtained from carbonic acid. By the energy derived from the sun's rays they are able to split up the carbonic acid, and assimilate the carbon. In the bacteria—organisms that do not contain chlorophyll—the carbon cannot, as a rule, be so obtained from carbonic acid through the agency of the sun. It must be assimilated from complex bodies, and the necessary energy must be supplied by the cell itself.

As already stated, schizomycetes contain more albuminous matter than the yeast or mould fungi, and it is natural to suppose that they nourish themselves most readily from those bodies which stand nearest to them in chemical constitution. In chlorophyll cells one of the early assimilation products is starch. In these cells assimilation consists in the decomposition of carbonic acid and water, and the formation in the first place of some simple body, probably formic aldehyde, thus :— $CO_2 + H_2O = CH_2O + O_2$. Nitrogenous compounds are next elaborated out of this, with the help of the nitrogenous salts absorbed. Probably amides are thus formed, *i.e.*, compounds containing amidogen, NH_2, *e.g.*, *Asparagin.* $\left\{\begin{matrix} CH\,(NH_2).\,CO_2H \\ | \\ CH_2\,.\,CO\,.\,NH_2 \end{matrix}\right\}$. From these, proteids are probably formed; and finally protoplasm. This is of course a purely

* Zeitschrift für Hygiene. Vol. I.

theoretical explanation. What the first assimilation-product is as regards schizomycetes, we do not know, but Nägeli suggests that it may consist of three carbon atoms + hydrogen and oxygen atoms, and that these unite with three more carbon atoms to form a complex molecule, consisting of six carbon atoms. Accordingly, the nearer to this hypothetical body in constitution is the food stuff, the more easily will it be assimilated.

Nitrogenous bodies in process of assimilation will undergo much more modification, and the simpler ones will have to be combined within the cell, with the carbon products. It is probable that the salts undergo modification as well.

Metabolism.

Metabolism.

Plastic and destructive.

In proceeding to consider metabolism it is important to form some mental picture of the metabolic changes that take place within cells, and to this end I briefly state the theory of Flügge.

Assimilated matter in the cell may undergo one of *two* changes: (1.) It may be converted into "plastic bodies," to be utilised in building up new cell-substance. (2.) It may be subjected to "destructive metabolism," *i.e.*, be partly destroyed by oxidation, and partly changed into bodies which being no longer nutrient, are thrown off as excreta.

The pre-eminently nitrogenous "plastic bodies" are the proteids, which are in part used to form cell-substance, and in part stored in the same. Nägeli found that yeast-cells in certain media excreted albumen and peptone.

Along with schizomycetes amides have also been found, *e.g.*, leucin and xanthin. They also appear in the *auto*-fermentation of yeast. They must be regarded as partly precursors of, and partly decomposition products of, the proteid stuffs. They are nutrient to bacteria, and in their presence a microbe can live on a minimal quantity of nitrogenous matter, *e.g.*, in distilled water.

A separation of distinct nitrogenous compounds as purely excrementitious products probably very seldom takes place, because these bodies are "plastic," and can be used again by the cells.

As regards non-nitrogenous bodies, these are only taken up in a minimal quantity by the cells in a state ready for assimilation. They may be formed in one of two ways: 1. Out of simpler compounds, *e.g.*, leucin. 2. Out of more complex molecules by decomposition, *e.g.*, peptones and albumen. Some of them are excrementitious, *e.g.*, oxalic, formic, and carbonic acids. All produce carbonic acid, and as it is given off it *lessens* the *nutrient value* of the soil. *Aromatic products* (phenol, skatol, indol), which may have an injurious action on the microbes producing them, are liberated.

In all these processes *intra*-cellular oxidation plays an important part, and liberates the energy necessary for metabolism.

"The higher plants by means of sunlight, acquire the necessary energy for the assimilation of carbon. The bacteria cannot do this, and their assimilation processes result at the expense of the energy set free by chemical change." (Flügge.)

Chemical products.

The number of chemical products of the bacteria are too numerous to mention. They vary with the nature of the soil, and with the nature of the microbe.

They may be divided into two groups: general and specific.

Amongst the universally found products may be mentioned carbonic acid, water and some nitrogenous body. Frequent products are fatty

and oxy-acids, and their amido-compounds; also aromatic bodies, *e.g.*, phenol and pigments.

Certain products are characteristic of certain microbes, *e.g.*, lactic and butyric acids. But as an instance of the diverse action of allied bacteria, it is worth mentioning that one group can not only produce carbonic acid, fatty acids, a ferment, and ptomaines; but may also possess pathogenic properties (commabacilli). The different results of course vary with the soil, *e.g.*, Koch's commabacillus only produces a brown pigment when grown on potato.

Many of the metabolic products react on the microbes producing them, *e.g.*, alcohol finally stops the growth of yeast, and the organic acids (lactic and butyric) have an antiseptic action. The non-pathogenic will grow at the expense of pathogenic microbes in culture fluids. This might be due to a difference in the rapidity of their growth. It may also be due to chemical products, though this is not yet proved.

How far specific.

Amidst such a variety of facts that have now been brought to light with regard to the chemical metabolism of bacteria, are we in a position to associate special chemical changes with different classes of microbes? Can we expect that a given bacillus will split up, *e.g.*, a proteid molecule always in the same way, and give each time identical products? Amongst these are there any which may be regarded as specific products of the bacterium in question? Research is leading us to answer these queries in the affirmative. That they can so be answered is of the highest importance to hygiene, in elucidating the causes of disease. At the very outset it is necessary to qualify this statement by another, viz., that the chemical isolation of these products is still in the initial stage, and that we do not yet know which amongst them are *common to* pathogenic and to non-pathogenic bacteria.

I will, however, mention a few facts which encourage research in this direction:—

Certain microbes are associated with special forms of fermentation, and in a suitable soil the same chemical changes always occur.

Certain microbes always liquefy gelatine, and so furnish an important diagnostic feature.

Others always produce a special pigment in given media. Under similar conditions these phenomena always take place. Thus, the above easily observed chemical changes are constant, and associated with special micro-organisms. Microscopically these may appear identical, but by cultivation some distinguishing chemical property very often appears.

It is for the future to decide how far these products are specific.

The conditions for accurate research are these:—

A suitable soil, thoroughly sterilised; inoculation from a pure culture; and control plates to detect accidental contamination. The experiments *always* to be made under similar conditions, *i.e.*, the external conditions must be kept equal. When we are testing the ferment action of a bacterium it must of course be grown in a fermentable soil, *i.e.*, where beyond merely nourishing itself, it can exert any special chemical activity of a ferment nature that may belong to it. It must also be kept at the optimum temperature, and the soil must always have the same composition.

We now pass to a survey of what is known regarding the *special metabolic products* of the bacteria.

For medicine the most important are ferment products; putrefactive products, and ptomaines. Before passing to their consideration two interesting chemical problems, associated with bacteria, deserve notice: *a.* Pigment production. *b.* Nitrification.

Pigment Production.

Production of pigments.

Certain classes of bacteria can produce colouring matters (red, green, blue, &c.) in given soils. Some of these colour changes have at times produced considerable alarm in the popular mind.

"*Bleeding bread*," as the phenomenon was called on the Continent, is due to the micrococcus prodigiosus. It produces in certain soils (bread, potato, gelatine), and in presence of oxygen, a red pigment; the micrococci being, however, *colourless*.

"*Green pus*" is due to the bacillus pyocyaneus. In milk the bacilli produce a yellowish green discolouration, precipitate and peptonise the casein, and set free ammonia.

Gessard isolated the pigment, which he called *Pyocyanin*. He found it to be a base allied to the ptomaines, and capable of crystallisation as a sulphate or chloride.

"*Blue milk*" is caused by the bacillus cyanogenus. The pigment is probably formed from the casein of the milk. Its nature has not been determined. The milk is not coagulated.

"*Cholera red*."—This name is applied to the red pigmentation, which appears in cholera cultures after the addition of a mineral acid (nitric acid). In 1848 Virchow found that the intestinal contents of patients who had died from cholera gave, on the addition of nitric acid, a red colour. Griesinger in 1866 obtained the same reaction with rice-water stools. Poehl,* on adding ferric chloride and ferricyanide of potassium to bacterial cultures, noted that Berlin blue was directly formed only in an acid medium. In alkaline media the blue appeared after the addition of a mineral acid. On adding hydrochloric acid to cholera cultures he obtained a red reaction. Bujwid† suggested that this might be used as a help to the diagnosis of cholera. Dunham‡ substituted sulphuric acid, and found the reaction favoured by the presence of peptones. Jadassohn§ proved that it only took place in aerobic cultures. It was supposed to be a special product, and that by its means one could diagnose the presence of commabacilli in cultures and in the stools. Brieger‖ proved that the pigment, which he isolated, was an indol derivative. Ali Cohen¶ also proved that its appearance depended on the presence of nitrous acid, which was probably present as an impurity in the nitric acid used for testing. The later investigations of Salkowski** show that it is a *common* indol reaction, dependent on the presence of nitrous acid. He suggests that the bacilli may form the nitrous acid out of ammonia. We must conclude that "cholera red" cannot be considered diagnostic of the commabacilli, because in cultures of many other bacteria indol and nitrous acid are simultaneously present.

These pigments do not as a rule exist in the cells or their membranes; they are generally found diffused in the media in which the microbes grow.

The earlier researches were made chiefly with potato cultures. Erdmann†† showed that some of these pigments resembled in their reactions similar anilin colours, *e.g.*, that associated with M. prodigiosus.

Wernich‡‡ investigated the colours produced by M. prodigiosus on various media.

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* Ber. d.d. chem. Ges. 1886.
† Zeitschrift für Hygiene. Vol. II.
‡ *Ibid.*, p. 337.
§ Bresl. arztliche Zeitschrift. 1887.
‖ Deutsche med. Wochenschrift. 1887.
¶ *Ibid.* 1887.
** Virchow's Archiv. 1887.
†† J. für Prakt. Chemie.
‡‡ Cohn's beiträge zur Biologie der Pflanzen. III.

Schroeter* concluded that the pigment is only separated in the surrounding media, since the mycelia of fungi become coloured without contact with the bacteria.

Cohn† defines pigment production as a specific physiological property of the bacteria, and describes two classes :—

I. Pigments soluble in water. The pigment spreads also in the media in which the bacteria grow.

II. Pigments insoluble in water. The pigment is confined to the protoplasm and intercellular substance.

Neelsen‡ states that in blue milk the pigment is not bound up with the bacteria (which are probably not coloured), but is dissolved in the serum of the milk.

Liborius states that pigments are only produced in aerobic cultures, and that anaerobically the fluid remains colourless. This would point to the bacteria secreting a body, which, by oxygen, is converted into a pigment, and that this is due to chemical process carried out in the substratum in which the microbes grow. Hueppe has recently controverted the statement that the pigments are universally oxidative products, inasmuch as spirillum rubrum only produces its pigment anaerobically, and a bacterium isolated by Holschewnikoff behaves similarly. Hueppe believes these *anaerobically* produced pigments to be basic decomposition products of albuminates, "colour ptomaines." The *aerobic* pigments arise, however, in another fashion, *e.g.*, the blue pigment formed in milk. In the milk a colourless "chromogen" is formed, which is an acid. This colourless acid unites with ammonia to form a greyish-blue salt, which salt in an acid solution becomes blue. Such aerobic pigments may be acid or basic, and by forming salts develop the colour. If these observations be confirmed, we must conclude that just as in the case of the colourless bacteria, there are aerobic and anaerobic species.

It is interesting to note that alizarin, the colouring matter of the madder plant, is formed by the action of a ferment contained in the roots. The ferment splits the acid into alizarin and glucose.

Nitrification.

Oxidisation.

Schlosing and *Müntz*, and later Warington, proved that soil bacteria converted *ammonia* into nitric acid. *Wollny* and *Fodor* showed that the oxidation of *carbon* into carbonic acid also took place by means of bacteria contained in the soil. *Gayon* and *Dupetit* proved the reverse process, a *reduction* of nitrates by certain microbes.

Heraeus§ was able to effect both oxidation and reduction with pure cultures.

Warington‖ did not succeed in demonstrating any active nitrification with the microbes he used, and says,—"An organism which nitrifies as soil nitrifies has yet to be isolated."

All these investigations as to the behaviour of bacteria in the soil are of great importance to us, more especially in reference to Pettenkofer's hypothesis as to soil being one of the great factors in the causation of epidemic disease. Further pathogenic microbes exist in many soils, *e.g.*, the bacillus of malignant œdema, and the cause of infectious tetanus.

The above investigations show that many bacteria are capable of chemical activity in the soil, more or less marked. It is especially

* Cohn's beiträge zur Biologie der Pflanzen.
† *Ibid.* I.
‡ *Ibid.* 1883.
§ Zeitschrift für Hygiene. Vol. I.
‖ Chemical action of micro-organisms. London. 1888.

incumbent on us therefore to investigate what effect the soil has on pathogenic bacteria. Do they remain quiescent, or do they continue to multiply? *Soyka* states that soil has a destructive action on poisonous bases, and on ptomanies.

With regard to all of the above points our knowledge is defective, and we cannot say definitely what hygienic significance the presence of bacteria in the soil possesses.

As regards the functional activity of bacteria in *water*, the influence they may have in determining the amount of nitrates and nitrites present, and as regards the harmonising of chemical and biological analyses no positive statement can be made. Earthy bicarbonates hinder, oxidisable organic matters favour their activity (Pöhl).

To test the *reducing* power of bacteria new methods have recently been devised, *e.g.*, the decolouration of litmus when added to the cultures. Baumgarten found that all the bacteria which liquefy gelatine reduce litmus.

Fermentation.

Fermentation

Fermentation is a process whereby complex chemical compounds are split up into simpler ones, accompanied by the liberation of heat; atoms passing from an unstable to a more stable state, and stronger affinities becoming satisfied.

The ferments have been divided into *two* classes—

1. The organised ferments.
2. The "*un*-organised" ferments.

The *organised* are living organisms, such as yeast and bacteria.

The "*un-organised*," though organic bodies do not possess life. To distinguish them from the organised, they are called *enzymes*, *e.g.*, diastase, ptyalin, &c.

One word of caution: the ferments which have been isolated are *not* chemical individuals, they are simply *precipitates* containing the active inducer of particular chemical change.

in plant life.

A. If we consider the *physiology of plants*, we find that, for purposes of nutrition, they can render soluble starch and proteids. This they effect by means of ferments, and the process is most probably in all cases an hydration. Four forms of fermentation are known:—

1. *The diastatic.*—*e.g.*, diastase, rendering starch soluble by converting it into sugar.
2. *The proteolytic.*—*e.g.*, papain, converting insoluble into soluble proteids.
3. *The glucosic.*—*e.g.*, emulsin, converting glucosides (compounds of sugar with an aromatic principle) into sugar and simple benzol derivatives.
4. *The inverting.*—changes cane sugar into grape sugar.

All these ferments act in the same way, viz., by hydration, *i.e.*, by the addition of the elements of water, the complex molecule is resolved into several simpler ones. They are isolable or *soluble* ferments—they can be separated and their action demonstrated apart from the cells which produce them. That the process is a *hydration* will be seen from the following formulæ:—

Diastatic fermentation:—

$$\underset{\textit{Starch.}}{C_{24}H_{40}O_{20}} + 3H_2O = C_6H_{10}O_5 + 3\underset{\textit{Dextrose.}}{C_6H_{12}O_6}.$$

Emulsin fermentation :—

$$C_{13}H_{18}O_7 + H_2O = C_6H_{12}O_6 + C_6H_4 . OH . CH_2OH.$$
Salicin. *Dextrose.* *Saligenin.*

Invert fermentation :—

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6.$$
Cane sugar. *Grape sugar.*

For the *proteolytic* fermentation there are no certain formulæ.

B. Turning to the *microbes* we find that they can produce *two* kinds of fermentation :— in microbic life.

1. Fermentation by *hydration*. The conversion of anhydrates into hydrates, *e.g.*, bacillus butyricus, thus,—

$$2\,(C_3H_6O_3) + 2\,(H_2O) = C_4H_8O_2 + 2\,(CO_3H_2) + H_4 =$$
Lactic acid.
$$C_4H_8O_2 + 2\,CO_2 + 2\,H_2O + H_4.$$
Butyric acid.

2. Fermentation by transference of *oxygen* atom *from hydrogen* to *carbon* atom, *e.g.*, the yeast fungi, thus,—

$$C_6H_{12}O_6 + 2\,(H_2O) = 2\,(C_2H_6O) + 2\,(CO_3H_2) =$$
Grape sugar.
$$2\,(C_2H_6O) + 2\,CO_2 + 2\,H_2O.$$
Alcohol.

Whether all of these changes are produced by *isolable* ferments or not is a matter for investigation, but in some cases at any rate it seems proved that microbes produce certain hydration effects (*e.g.*, liquefaction of gelatine), by means of a soluble ferment, capable of acting apart from the cells that produce it.

C. Fermentation in *animals* :— in animals.

This is brought about in the digestive tract by means of *soluble* ferments, of which the pancreatic are types. The pancreatic ferments digest the three great groups of foodstuffs: the *proteids* are converted into peptones; the *carbohydrates*, into dextrin and sugar; the *fats*, into glycerine and fatty acids. The process is one of hydration, certainly in the last two, and most probably in the first.

Within the body, the changes are chiefly forms of *oxidative* decomposition; whether these are due to special ferments or not we are ignorant. It is a moot point whether Schmiedeberg's *histozyme*—a ferment isolated in the blood—can originate such processes.

To sum up, we find that there are *three* forms of decomposition of organic bodies, associated with the phrase "*Fermentation*" :— Fermentation, results classified.

i. *Simple decomposition*.—A splitting into two or more compounds, with transference of O or H to the C atom.

$$C_6H_{12}O_6 = 2\,C_2H_6O + 2\,CO_2.$$
Dextrose. *Alcohol.*

ii. *Hydrolytic decomposition*.—The addition of the elements of water :—

$$4\,C_6H_{10}O_5 + 3\,H_2O = C_6H_{10}O_5 + 3\,C_6H_{12}O_6.$$
Starch. *Dextrine.* *Grape sugar.*

iii. *Oxidative decomposition*.—The breaking up of a body into products, which by the action of oxygen become oxidised, *e.g.*, the decomposition of *alloxan* into urea, oxalic acid, and carbonic acid; the *oxalic acid* under the action of oxygen finally splitting up into carbonic acid and water, *sic* :

$$CO\begin{cases}NH-CO\\NH-CO\end{cases}CO + 2\,H_2O + O = CO\begin{cases}NH_2\\NH_2\end{cases} + \begin{matrix}CO.OH.\\CO.OH.\end{matrix} + CO_2.$$
Alloxan. *Urea.* *Oxalic Acid.*

Special Fermentations induced by living Organisms.

A distinction must be drawn between enzyme action and the action of organised ferments, as the process in each case seems to differ.

A. *Fermentations* produced by *microbes*, which are analogous to the action of *enzymes* :—

i. *Diastatic* fermentation, *e.g.*, bacillus acidi lactici.

ii. *Invert* fermentation, *e.g.*, penicillium and aspergillus; yeast fungi.

iii. *Cellulose* fermentation, *e.g.*, vibrio rugula. It is probable that cellulose is dissolved in the digestive tract by ferment bacteria.

iv. "*Peptonising*" fermentation, *e.g.*, the bacteria which liquefy gelatine.

v. *Milk* fermentation (curdling of milk), *e.g.*, bacillus acidi lactici. It splits the milk sugar into lactic acid and carbonic acid, and the acid produces a precipitation of the casein.

vi. *Urea* fermentation, *e.g.*, micrococcus ureæ. The urea is converted into carbonate of ammonia.

B. Strictly *organic* fermentations :—

The *specific* fermentations produced by bacteria which we are at present acquainted with are as follows :—

i. *Alcoholic* fermentation of sugar; by the *yeast* fungi. It is produced in glucoses having the general formula $C_6 H_{12} O_6$; and, *after* hydration in maltose, $C_{12} H_{22} O_{11} + H_2 O$.

The most active are the *beer* and *wine* torulæ. To understand the process, one must know the chemical structure of the carbohydrates.

The *carbohydrates* contain six, or a multiple of six atoms of carbon, and in them the relation of hydrogen and oxygen is the same as in water. There are *three* groups :—

1. *Glucose* group, *e.g.*, dextrose, $C_6 H_{12} O_6$.
2. *Cane sugar* „ *e.g.*, maltose, $C_{12} H_{22} O_{11}$.
3. *Cellulose* „ *e.g.*, starch $(C_6 H_{10} O_5)$ n.

All these are fermentable but only the *first* group can be converted by the yeast fungi into alcohol. The last two groups, by means of *other* ferments, can be changed into bodies capable of undergoing alcoholic fermentation.

(1.) *Starch* by the action of an *enzyme* can be changed into *maltose* :—

$$3\,C_6 H_{10} O_5 + H_2 O = C_{12} H_{22} O_{11} + C_6 H_{10} O_5.$$
Starch. *Maltose.*

(2.) *Maltose* by the action of an *enzyme* formed by the torula is changed into a *glucose* :—

$$C_{12} H_{22} O_{11} + H_2 O = C_6 H_{12} O_6 + C_6 H_{12} O_6.$$
Maltose. *Dextrose.*

(3.) The *torula* acting on the *dextrose*, converts it into *alcohol* and carbonic acid :—

$$C_6 H_{12} O_6 = 2\,C_2 H_6 O + 2\,CO_2.$$

This last change is not so simple as is represented by the formula. Bye products are formed as well, viz., glycerine, succinic acid, fusel oil, acetic acid, &c.

When the alcohol reaches 12°/₀, the torula is hindered in its development, and 14°/₀ stops further fermentation. The significance of the bye products has been discussed. Are they ferment products, or metabolic products of the torula, or are they due to the action of *other* microbes? Pasteur's experiments do not exclude the possibility of

bacterial contamination, because he was not able to make pure cultivations of the yeast fungi.

Hansen, the latest worker in this field, has been able to isolate six forms of saccharomyces, and thus we may hope soon to be in a position to settle the origin of these bye products.

ii. Fermentation by *schizomycetes*:—

a. Of *carbohydrates*:—

α. Lactic acid fermentation, by, *e.g.*, Bac. acid. lactici. Glucoses are converted into lactic acid, and carbonic acid is given off. When the lactic acid reaches 0·8%, and is not neutralised, fermentation stops. It is probable that the bacillus hydrates the *sugar* in the milk, *i.e.*, converts it into a glucose, before the special fermentation takes place. The formula usually given is—

$$C_6 H_{12} O_6 = 2 (C_2 H_4 . OH . COOH).$$
Lactic acid.

But this does not explain the formation of *carbonic* acid. Perhaps it is due to the action of a *second* bacterium.

β. Butyric acid fermentation, by, *e.g.*, bacillus butyricus:—by which starch, cane sugar, and dextrose are fermented. The one important product is butyric acid, $C_4 H_8 O_2$; but along with it we find acetic acid, alcohol, $C O_2$, and hydrogen. The conversion of sugar into butyric acid, &c. is one of the most complete decompositions of an organic body by a ferment with which we are acquainted. The bacillus butyricus produces the change *anaerobically*. Pasteur, who first described anaerobiosis, believed it to be the cause of fermentation. But now fermentation is regarded as a process not necessarily dependent on the presence or absence of air.

γ. Mannitic fermentation, by, *e.g.*, micrococcus viscosus:—This produces viscosity in wine by acting on the sugar, and forming a peculiar gummy body, viscose.

Amongst other fermentations may be mentioned the conversion of *glycerine* into alcohol, and of *fatty acids* into propionic and acetic acid.

Finally, the conversion of the *alcohol* in fermented liquors into acetic acid by the bacillus aceticus—

$$CH_3 . CH_2 OH . + O_2 = CH_3 . COOH + H_2O$$
Acetic acid.

Fermentation. Summary.

To sum up our present knowledge regarding fermentation:—

As to the distinction between enzymes and organised ferments:—The enzymes of plants and animals are soluble chemical bodies, whose ferment action is not necessarily dependent on the presence of the living cells which produced them. The organised ferments are living cells from which the specific ferment has not been separated. In the absence of the cells, the particular fermentation does not take place. The chemical changes produced by enzymes are simple ones, and the process is eminently a hydration, for which the optimum temperature is higher than that for the organised ferments. The chemical changes produced by organised ferments are more profound; a displacement and re-arrangement of atoms in the molecule takes place, accompanied generally by the evolution of gases. The optimum temperature lies somewhat lower than in the former case. While the fermentation produced by organised ferments is regarded as a physiological function of the cell, that produced by the unorganised is regarded as due to an isolable body secreted by the cell. Many bacteria produce results similar to enzyme fermentation. The question naturally has arisen, do these bacteria secrete an enzyme, like the cells of the stomach and pancreas? Bitter found that

gelatine liquefied by Koch's commabacillus, *after* sterilisation, liquefied fresh gelatine. Sternberg states that he found the same phenomenon with cultures of other liquefying bacteria. Rietsch found, though his experiments were not sufficiently controlled, that precipitates from cultures of pyogenic staphylococci and commabacilli were capable of digesting (peptonising) fibrin. The experiments made by Dr. Brunton and myself support the correctness of the above statements:—namely, that the bacteria which liquefy gelatine do so by means of an *enzyme;* that the enzyme can be isolated, and its action demonstrated apart from the cells by which it was secreted. Further, we found that the *same* bacteria were capable of forming a diastatic enzyme on carbohydrate soil, and that a given bacterium can, for purposes of its own nutrition, modify its ferment action in reference to the soil on which it chances to grow.

All these experiments tend to prove that bacteria, like the cells of plants and animals, can secrete isolable enzymes, and that it is in virtue of these isolable bodies that they produce analogous results. Whether the organised ferments do so or not is a matter for further investigation. In the case of the torula the specific alcoholic fermentation must be regarded as a physiological function of the cell; but the hydration of maltose may be due to an enzyme, since a watery extract of the torula also inverts maltose; and similarly with the hydration products of other organised ferments.

The ferment action of bacteria has important medical bearings. Many ferment bacteria have been found in the digestive tract, where they probably cause abnormal fermentations in the food stuffs, with the result that lactic, acetic, and butyric acids, and gases are formed in the stomach, and the symptoms of flatulent dyspepsia ensue. Further, they are regarded as the causes of many intestinal maladies in children of a diarrhœal nature, arising from milk fermentation. They probably take part in the intestinal digestion of cellulose. Bacteriological investigation in this direction, whilst explaining many morbid processes, is contributing at the same time to a rational therapeusis. Thus I found that the organic acids, which may arise in the stomach, are powerfully antiseptic to bacteria, more so indeed than the hydrochloric acid of the gastric juice. So, therapeutically, lactic acid would, in certain dyspeptic conditions, be more likely to prove useful than hydrochloric acid. Useful hints are also to be got as to the most suitable diet.

From the normal intestine of the child Escherich has isolated a bacterium which ferments the sugar of milk. He further found that the putrefactive fermentation of proteids did not occur so long as milk sugar was present. Therefore, in the putrefactive fermentation of proteids in the lower intestine a carbohydrate diet would be indicated, on account of the inimical action of the lactic acid on the putrefactive fermentation.

The cases of poisoning by food are probably intoxications due to poisonous bases formed, outside the animal body, by bacteria in the *early* stages of decomposition of these foods. Vaughan isolated from cheese a poisonous base, "tyro-toxin," which produces symptoms similar to those in cholera infantum.

Directions for further research.

Sufficient has been said to indicate the importance of investigating the ferment products of bacteria: and there will be convenience in now summarising the points to be held in view in prosecutiug further research.

I. All investigations, where possible, to be made with *pure cultures;* so many of the earlier experiments were vitiated because

made with impure cultures. Further, the results observed may partly arise through the action of bacteria not yet isolated, *e.g.*, the alcoholic fermentation and its bye products.

II. The investigation of the *chemical mechanism* of fermentation is not so simple as was at first supposed. For example, it was believed that starch by fermentation was wholly converted into dextrose. Recent research has shown that only one half becomes sugar, which is maltose and *not* dextrose. The rest is dextrin. Further, it has been proved that there are intermediate products. Between starch and dextrine there is a body called soluble starch. Even the starch is not a pure chemical body, but consists of several carbohydrates.

III. Direct experiment is wanted to decide whether the *enzyme-like action* of bacteria is due in all cases to an isolable ferment, and whether the organised ferments secrete enzymes.

IV. Also we require to know whether many ferment products are not *mixed* results, *i.e.*, due to the action of more than one bacterium,—*e.g.*, the bye product *fusel oil*, which is due, not to the torula, but in all probability to a schizomycete; so too the production of carbonic acid, &c. In kephir (alcoholic sour milk) the fermentation is probably produced by the combined activity of three kinds of microbes: dispora caucasica, saccharomyces, and bacilius acid. lactici.

V. The influence of *aerobic* and *anaerobic* conditions also deserves study. Are some of the bacteria we have not been able to isolate, truly anaerobic? Anaerobic cultures often give a deeper insight into the chemical metabolism of a microbe.

VI. Information too is wanted respecting the influence of the ferment products on the bacteria manufacturing them, *e.g.*, their antiseptic properties, as in the case of the organic acids of the food stuffs. Also of their possible therapeutic value, and of their influence on *other* bacteria—is it of a toxic nature, and, if so, what is the toxic product?

VII. The influence of soil on ferment activity, seems especially deserving of study.

VIII. Again investigation of the bacteria in the digestive tract is highly necessary, along with inquiry into their ferment action.

IX. The putrefactive products formed, outside the animal body, in food stuffs, require to be better understood. Amongst those are there basic poisonous bodies which would explain the intoxication sometimes produced by the consumption of meat, fish, cheese, &c.?

Putrefaction.

Putrefaction.

Nature of chemical changes.

Putrefaction is the decomposition of nitrogenous bodies, especially the proteids, by schizomycetes—this decomposition being accompanied by the evolution of foul gases. A large number of bacteria can produce these results.

The first research that gave us any knowledge regarding the changes produced in nitrogenous bodies by bacteria was Nencki's, and I purpose giving a summary of his suggestive results.

Nencki* studied the decomposition of albumen and gelatine with pancreas. He states that inasmuch as all the products formed in the putrefaction of albumen can be obtained also by treating the albumen with potash, the study of the latter process will make clear the chemical means by which putrefactive bacteria decompose albumen.

* Ueber die Zersetzung der Gelatine, &c. Berne. 1876.

In the decomposition of simple and complex amides, amido-acids, simple and complex ethers, anhydrates, glucosides, &c., by dilute acids the change is always brought about by the help of water.

In similar fashion one best understands the process with alkalis, when one regards them as alkalihydrates, *i.e.*, H_2O, in which one H. has been replaced by potassium, sodium, &c. Therefore dilute acids and alkalis are called hydrating agents, and the decomposition of organic bodies by them is called decomposition by *hydration*. In these cases the molecule of water breaks up thus: $H_2O = H + HO$, NOT $H_2 + O$; *i.e.*, it forms a hydroxyl group. The alkali breaks up thus: $KOH = KO + H$. By way of example, let us take it acetamide. This body heated with caustic potash forms acetate of potassium and ammonia, *i.e.* the H of the KOH enters the amido group NH_2, and the remainder KO joins with the acetyl to form acetate of potash, *sic*:

$$C_2H_3O.\underline{NH_2} + \left.\begin{matrix}H\\K\end{matrix}\right\rangle O = NH_3 + C_2H_3O.OK.$$

Acetamide. *Potass. acetate.*

Thus it is seen that the alkali hydrates behave, in fact, like water.

The products formed out of proteid bodies by putrefaction, with or without air, are the same, viz.:

1. *Hydration* products.—Leucin; peptone; amido-valerianic acid; tyrosin; glycocol.

2. *Volatile* products.—CO_2; NH_3; volatile fatty acids; and reduction gases, such as hydrogen, sulphuretted hydrogen, and marsh gas.

3. *Characteristic putrefactive* products. Skatol; indol; and phenol. With the appearance of phenol, tyrosin disappears.

The key to this decomposition Nencki believes is to be found in the action of *potash* on albumen. With potash, Bopp* got the following results:—

Albumen heated with potash for a few hours gave as the *first* decomposition products:—Pepton, leucin, tyrosin, carbonic acid, and ammonia.

When the mixture was heated till hydrogen gas developed, volatile fatty acids formed.

With a larger quantity of potash and more heat, the peptonic matter lessened; the fatty acids increased; tyrosin disappeared; and phenol appeared, as well as skatol and indol.

After *five* days' heating, *all* the albumen was changed into CO_2, NH_3, butyric acid, and aromatic bodies.

That is to say *potash*—

(1.) Hydrates the albumen forming, CO_2; NH_3; amido acids.

(2.) Oxidises the latter, under development of hydrogen, to volatile fatty acids.

Comparing these results with the *putrefactive* process (albumen and pancreas at 40° C.), we find formed—

(1.) Peptone, leucin, tyrosin, amidovalerianic acid.

(2.) Tyrosin disappears, phenol appears; also hydrogen, sulphuretted hydrogen, and volatile fatty acids.

After 3–4 days' digestion, the maximum amount of indol appears; and the leucin which arises by hydration becomes changed into—

a. Valerianate of ammonia.

b. Butyrate „ „

* Annales Chem. Pharm. 69, 30.

The amount of peptonic matter continues to decrease, till finally, after two weeks, of 100 parts albumen there remain—

8·94	grm.	NH_3.
3·06	„	CO_2.
44·06	„	butyric acid.
13·6	„	peptonic matter.

To sum up, in putrefaction water plays the part of caustic potash (KOH), *i.e.*, KOH = K + OH, and $H_2O = H + OH$. The putrefactive microbe acting on water splits it up into H + HO, and renders possible *both* hydration and reduction. By this means we are able to explain the action of putrefactive microbes on complex organic bodies. Take for example *leucin* (amidocaproic acid), and its decomposition by bacteria:—

(1.) *Leucin* $CH_2(NH_2).(CH_2)_4.CO_2H + \begin{matrix}H\\H\end{matrix}\!\!>\!O = NH_3 + OH.(CH_2).(CH_2)_4.CO_2H.$

Oxycaproic acid.

(2.) The oxycaproic acid acted on by a second molecule of H_2O becomes split up into methylene glycol and valerianic acid, *sic:*

$$CH_2(OH).(CH_2)_4.CO_2H + \begin{matrix}OH\\H\end{matrix} = CH_2(OH)_2 + CH_3.(CH_2)_3.CO_2H.$$

Oxycaproic acid. *Methylene glycol. Valerianic acid.*

(3.) The methylene glycol + another hydroxyl group (HO) would be further split up into carbonic acid and hydrogen, *sic:*

$$C\begin{matrix}H\,H\\O\\H\,H\end{matrix} + \begin{matrix}OH\\OH\end{matrix} = CO\langle\begin{matrix}OH\\OH\end{matrix} + 2\,H_2.$$

Thus, like fermentation, putrefaction requires the help of the elements of water, and is like it a *hydration* process. Analogies with fermentation;

We can only understand anaerobic putrefaction, on the supposition that the bacteria can split up water into H + HO, and so render possible both oxidation and reduction.

These briefly stated are Nencki's results with regard to the putrefactive products of albuminous bodies and the method of their origin. It remains to add that the products from albumen and gelatine differ *qualitatively* and *quantitatively*.

Gelatine in putrefaction yields *no* tyrosin, only leucin and glycocol. Neither indol nor phenol are formed in gelatine; also the fatty acids formed are *different*. From gelatine we get acetic acid; from egg-albumen, butyric along with some valerianic acid.

Dr. Walchli investigated the products in substances neither albuminous nor gelatinous.

Elastin, yielded NH_3; CO_2; leucin, valerianic acid, and glycocol.

Mucin yielded indol, phenol, and butyric acid.

These facts are of great interest. The products of bacteria are apt to vary both qualitatively and quantitatively, according to the soil in which they are grown. They also show that intestinal digestion may be in with digestion.

great part a putrefactive process. Whilst the splitting up by hydration suggests a close analogy to the action of soluble ferments, there is a marked difference to be observed. The hydration changes produced by soluble ferments are superficial, compared with those occurring in putrefaction. In fermentation the albumen is converted into peptones. In a recent work Wigand,* a professor of botany, states that putrefaction occurs without the aid of bacteria. The methods he used were antiquated, and could not lead to trustworthy results. Besides, he had committed himself to the theory of the spontaneous origin of bacteria in the cells of plants, an illusion which a drop of hydrochloric acid soon dispels. (De Bary.)

Baumann† first discovered phenol as a product of proteid putrefaction, and Brieger‡ proved its presence in the large intestine of man. He found that the amount increased in septicæmia and peritonitis.

Brieger's observations led him and others to suppose that by estimating the phenol excreted we could arrive at conclusions of clinical value with regard to the putrefactive changes going on in the intestine. But the amount excreted is usually small, and varies greatly, and four *other* aromatic acids have been obtained as putrefactive products.

A certain number of bacteria produce *sulphuretted hydrogen* from albumens. Holschewnikoff§ states that this occurs in egg cultures, and that all the commabacilli are so endowed. It may be found that in the digestive tract sulphuretted hydrogen is a metabolic product of bacteria. Sulphuretted hydrogen is readily absorbed by the blood, and the headache and giddiness occurring in cases of intestinal catarrh may be due to its poisonous action.

Reference will be made to the basic products of putrefaction under the heading "Ptomaines."

Products of putrefaction.

Whilst putrefactive decomposition has certain marked features which serve to distinguish it from other forms of chemical change, it is undoubtedly the case that the products of this decomposition vary greatly. Very many bacteria are capable of bringing about the change, and it is evident that, according to the degree of functional activity they possess, the splitting up of the proteid molecule will vary in completeness.

These bacteria must therefore be investigated individually as to their action, and the attempt made to determine what the products are in each case. Putrefaction is such a rapid process that bodies formed in the earlier stages become broken up and disappear. I have mentioned the disappearance of tyrosin simultaneously with the appearance of phenol and fatty acids. I would lay stress on the importance of this point in connexion with the investigation of putrefactive products that are toxic. The exquisitely poisonous bodies are bases, and their origin would be more likely to take place before the proteid molecule fell to pieces. In cases of food poisoning, the food, before consumption, can only have undergone a very partial decomposition.

As regards the significance of the *non-basic* metabolic products, our knowledge is very incomplete and inexact. We do not know to what extent they are responsible for morbid processes in the intestine. All we know is that the same products that are found in the digestive tract can also be produced by bacteria *outside* the body. Additional facts must be gained regarding the nature and action of the bacteria normally present in the intestine. The formation of phenol, indol, &c.,

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* Das Protoplasma als Fermentorganismus. 1888.
† Zeitschrift für Physiol. Chemie. I., 63.
‡ Journal für Prakt. Chemie., 17.
§ Fortschritte d. Medicin. 1889.

led to the supposition that these aromatic bodies were the main factors in hindering the further development of the microbes.

Nencki was the first to suggest this hypothesis. Wernich found that putrefaction was stopped by 0·05% skatol and 0·1% indol. The amount of these bodies present in putrefying mixtures is, however, *smaller* than that necessary to stop the process. They are also supposed to have a toxic effect on other bacteria, and to prevent their growth. If so, this would explain the death of the commabacilli when grown with putrefactive microbes. The recent investigations of Sirotinin make it very doubtful if the antiseptic action of these metabolic products is so marked as was at first supposed. He comes to the conclusion that free acid, excess of alkali, and carbonic acid play an important rôle in producing the antiseptic effect. Our knowledge is in a transition stage, and further inquiry is necessary.

Ptomaines.

Ptomaines,

The ptomaines are basic compounds which are formed in the decomposition of proteid bodies.

Arising as they do out of the most heterogeneous animal and vegetable substances, their number must be very great, and it is not to be wondered at that our present knowledge regarding them is still so crude and incomplete. The group of ptomaines of which we have most knowledge are the putrefactive or cadaveric alkaloids. Those which have been isolated vary in composition and action. Some are highly toxic, others very slightly so or not at all. A certain number give reactions similar to those of the vegetable alkaloids, and produce analogous physiological effects. This renders their study of great importance to toxicology. That they can arise from the action of bacteria brings them within the circle of medical investigation.

their part in morbid processes?

While Nencki was able to demonstrate the metabolic products arising from putrefaction generally, our more perfect methods enable us to investigate the products of *individual* bacteria, and to determine what these are. Also, by the slow accumulation of facts and their final correlation, to answer questions such as these:—Are there specific products associated with specific organisms? Do any of these products produce toxic effects of a specific nature? Are such toxic bodies formed by the pathogenic bacteria? If so, do pathogenic bacteria form specific ptomaines? Do they supply a link between the microbe and the symptoms which follow its introduction into the body?

There are three possible theories, as to the means by which bacteria produce their pathological effects within the animal body:—

1. That they act mechanically. A wholly insufficient explanation.
2. That they use up nutrient material, the assimilation of which is necessary for the healthy metabolism of the body. This does not suffice to explain the phenomena.
3. That they produce poisonous metabolic products which act on the body independently of their reproduction and nutrition. This theory has much to be said in its favour. (Fraenkel.)

It has been proved that the bacteria produce complex chemical changes, and Nencki's researches show that these changes (*e.g.*, the putrefactive) go on *inside* as well as outside the body. But such metabolic products are not formed in sufficient quantity in the body to account for the symptoms of disease. The discovery of ptomaines, and amongst them bodies toxic in minute doses, has encouraged the hope that in them we have the actual causes of disease. So firmly has

this theory taken root, that with many it has become a mental habit—an idée fixe. Hence "ptomaines" have been thought of as serving to explain—

1. The poisoning of the system from wounds.
2. Poisoning by the consumption of unwholesome articles of food.
3. Acquired immunity.
4. The action of pathogenic microbes.

Do the pathogenic bacteria produce not only alkaloidal toxic bodies, which differ from the ordinary putrefactive alkaloids, but differ also amongst themselves?

Enumeration of

The *first* step in such an inquiry is the investigation of the *putrefactive* alkaloids.

*Panum** was the first to isolate a chemical poison from putrid matters, which produced curari-like symptoms, and an inflammation of the small intestine.

Bence Jones and *Dupré*† discovered in putrid liver an alkaloidal body which they named "animal chinoidin."

Then *Schmiedeberg* and *Bergmann*‡ found in putrid yeast "sepsin," which was poisonous to dogs and frogs.

Zeulzer and *Sonnenschein*§ separated from the human cadaver a body which behaved like atropin; and Rorsch and Fasbender,‖ a base resembling digitalin. Other workers isolated a variety of cadaveric alkaloids. The most active worker in this field was Selmi,¶ an Italian chemist, whose researches were in his time of signal service to medical jurisprudence. In the celebrated case of the widow Sonzogno, of Cremona, who was supposed to have been poisoned, the experts, after exhuming the body, found morphine. Selmi was able to show conclusively that the supposed morphine was in reality a ptomaine. Unfortunately Selmi never succeeded in isolating a pure ptomaine; all his extracts were *syrups*, *non*-crystalline. Many recent observers have extracted from blood, meat, urine, &c., toxic bodies which they call ptomaines. As Brieger points out, all such researches, which are held to have proved the existence of ptomaines, are based on chemical reactions and animal experiments. In none of these cases has the toxic substance been isolated as a chemical entity, and its constitution ascertained.

It was Nencki** who first isolated from putrefactive matters a basic body in a state of chemical purity. From putrefying gelatine he extracted a *crystallisable* body, *collidin*, $C_8 H_{11} N$.

Collidin was the first pure ptomaine isolated.

Brieger's researches

The most important contributions to our knowledge of the basic products of putrefaction have been made by Brieger.†† The three cardinal points of his so eminently successful investigations were these:—

1. In no body separated must the index of chemical purity, the crystalline form, be lacking, so that chemical analysis may be possible.
2. What are the physiological properties of this chemically pure body?
3. Out of what organic compounds is it formed?

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* Virchow's Archiv. Vol. 60. 1874.
† Zeitschrift für Chemie. 1866.
‡ Medic. Centralblatt. 1868.
§ Berliner klin. Wochenschrift. 1869.
‖ Berichte d. d. chem. Ges. 1874.
¶ Sulle ptomaine. Bologna. 1878.
** Ueber die Zersetzung der Gelatine. Berne. 1876.
†† Ueber Ptomaine. Berlin. 1885-86.

We should expect that the basic products would vary with the different bodies acted upon. Brieger found that only in the first stage of putrefaction the poisonous products formed. After eight to ten days at higher temperatures, he could find, beyond ammonia, no toxic products.

I append an abstract of his results :—

in digestion ;

A. *Ptomaines* formed in the *digestion* of *fibrin*.

In the early stages of the decomposition of animal substances, and before any profound disintegration has taken place, he found toxic properties developed. The very first product of proteid metabolism—peptone—produced toxic effects when injected into the blood. Fibrin digested at body temperature with gastric juice, yielded a toxic extract —peptotoxin. It killed frogs and rabbits. It could *not* be isolated out of undigested albumen. There were no signs of putrefaction in the fluid.

It is very difficult to understand the presence of such a poisonous property in peptones, much more so to explain its origin.

in putrid fibrin ;

B. *Ptomaines* from *putrid meat :—e.g.*, horseflesh.

Brieger isolated a crystallisable body salt having the empirical formula $C_5 H_{14} N_2$. It was named *neuridin* from its relation to neurin, $C_5 H_{13} NO$.

This is the first diamide isolated out of animal tissues, and seems to be a common product.

It is *non*-poisonous. Chemically it consists of equal molecules of di- and tri- methylamine.

Neuridin is not the only basic product in meat putrefaction. After its separation, the residue exerts a *toxic* action, and from it was extracted the base *neurin*. Neurin produces toxic symptoms, of which the chief are salivation, dyspnœa ; acceleration, and then slowing of the heart's action ; intestinal peristalsis, and diarrhœa ; finally, convulsions and collapse ending in death. (Rabbits were the most susceptible.) Brieger further discovered a most interesting fact, viz., that *atropin* is a powerful antidote for neurin. All the symptoms have a close resemblance to those produced by muscarin. The formation of neurin, by the action of putrefactive microbes, out of nitrogenous bodies, is a fact of great importance. It helps us to understand how easily chemical change could give rise to highly toxic compounds in the body.

Neurin is not to be confounded with cholin ($C_5 H_{15} NO_2$). Cholin produces an intoxication only in very large doses.

Cholin is an oxy. ethyl. ammonium base,

$$(CH_3)_3 . N . OH . C_2 H_4 . OH.$$

Neurin is a vinylammonium base,

$$(CH_3)_3 . C_2 H_3 \quad N . OH.$$

[The *Vinyl* group $C_2 H_3 = CH_2 | CH$]

In studying the production of these poisonous alkaloids, we must understand the structure of cholin and its compounds. Cholin is widely distributed in the animal body ; it was first discovered in the bile, hence its names cholin or bili-neurin. It is found in the brain and the yolk of egg, and in these enters into the formation of a compound

called *lecithin* (Protagon) $C_{42}\,H_{86}\,NPO_9$. Lecithin may be regarded as a compound of cholin, with glycerine-phosphoric-acid and fatty acids (palmitic and stearic). Cholin is strongly basic. If we oxidise it with nitric acid, we obtain the poisonous alkaloid *muscarin*, $C_5\,H_{15}\,NO_3$. Further, by the action of hydriodic acid and silver nitrate on cholin we obtain *neurin*, $C_5\,H_{13}\,NO$, just as Brieger obtained it in cadaveric putrefaction. Cholin arises in the beginning of cadaveric putrefaction and neurin later on (5–6 days).

Having regard to the wide distribution of lecithin in the animal body, we may suppose that *cholin* arises from its decomposition.

The *neurin* could arise out of the cholin, by the separation of a molecule of water.

$$\underset{\textit{Cholin.}}{C_5\,H_{15}\,NO_2} = \underset{\textit{Neurin.}}{C_5\,H_{13}\,NO} + H_2\,O.$$

Muscarin could form from cholin by simple oxidation :—

$$C_5\,H_{15}\,NO_2 + O = C_5\,H_{15}\,NO_3.$$

Thus by splitting up lecithin we obtain cholin. And up to the present cholin has yielded two poisonous alkaloids, neurin and muscarin. By oxidation of cholin a base can be formed having the formula $C_5\,H_{11}\,NO_2$ = betain or oxyneurin.

From these chemical considerations it will be seen that there exist widely distributed in the animal body, organic substances which, by the action of bacteria, might easily yield toxic ptomaines.

in putrid fish;

C. *Ptomaines* from *putrid fish.*

Poisonous symptoms in the human being have occurred from the consumption of fish. This led Brieger to examine fish for ptomaines.

He succeeded in obtaining a toxic base isomeric with *ethylene-diamine*, $C_2\,H_4\,(NH_2)_2$. After its separation the residue yielded a syrupy fluid, analogous to *muscarin* in its action. Minimal doses produced in rabbits salivation and lachrymation, contraction of the pupil, profuse diarrhœa, incontinence of urine, convulsions, and in the end death. A third ptomaine obtained by him, *gadinin*, was nonpoisonous.

in cheese;

D. *Ptomaines from cheese.*

Brieger obtained from cheese bodies probably identical with neurin and trimethylamine.

From cheese Vaughan* obtained the toxic body, tyrotoxin. He was also able to obtain tyrotoxin experimentally by inoculating milk with the butyric acid ferment.

in gelatine;

E. *Ptomaines* from *putrid gelatine.*

Brieger isolated from putrid gelatine a large quantity of neuridin, dimethylamine, and a syrup which acted like muscarin.

As regards *putrefactive alkaloids* and their study, the important step in advance has been isolation of some of them as *pure* chemical bodies. Further, with such pure ptomaines Brieger has been able to produce highly toxic symptoms, *e.g.*, the action of neurin on rabbits. We also find that they can easily arise from the decomposition of complex organic bodies such as lecithin and cholin, indeed they must be formed from complex organic bases. We are able, by purely chemical means, to split up cholin into poisonous bodies; how much greater the capacity of a living cell.

* Archiv. für Hygiene. Vol. VII.

From the human cadaver Brieger isolated the following basic bodies, which are to be regarded as distinctively *cadaveric alkaloids* :—

Cholin	-	$C_5 H_{15} NO_2$.
Neuridin	-	$C_5 H_{14} N_2$.
Cadaverin	-	$C_5 H_{16} N_2$.
Putrescin	-	$C_4 H_{12} N_2$.
Saprin	-	$C_5 H_{16} N_2$.
Trimethylamine		$(CH_3)_3 N$.
Mydalein.		

The majority of these cadaveric ptomaines are diamines, and are not of very complex structure. In this respect they *differ* markedly from the vegetable alkaloids. The latter are much more complex, and almost all contain a pyridin nucleus. The majority of the cadaveric alkaloids are nonpoisonous, cholin and trimethylamine produce intoxication only in very large doses; but *mydalein* has quite a specific action.

Five milligrammes of *mydalein* produced the following symptoms in a cat : profuse diarrhœa and vomiting, increased flow of saliva, persistent licking with the tongue, dilated pupils, and lachrymation, and the paws were covered with sweat. The animal lay down and became lethargic for a time, then it suddenly jumped up, again to collapse. The hind legs were paralysed, and death was ushered in by torpor.

Post mortem.—Heart in diastole. The intestine partially filled with a thin fluid secretion, and the mucous membrane slightly injected.

One fact has been omitted from its proper place. In Wilhelmshafen a number of people were suddenly seized with the symptoms of acute irritant poisoning. It was found that they had all partaken heartily of certain mussels for which the town is famous. Brieger found in mussels taken from the same bed a *base* which he regards as the specific poison, *mytilotoxin*, $C_6 H_{15} NO_2$. It is highly toxic to animals.

From the same mussels he extracted *betain*, the base closely allied to cholin.

F. *Ptomaines* from *cultures* of *pathogenic bacteria*.

in pathogenic cultures;

> "If certain diseases are to be regarded as the outcome of a "poisoning, induced by microbes which have penetrated into the "body, the toxic principle must be capable of isolation."

If the pathogenic bacteria are capable of producing ptomaines, it is not to be supposed that they will do so on every soil in which they are grown. They will only produce ptomaines in certain media, and under certain conditions, *e.g.*, in meat broth.

Brieger searched for ptomaines in the cultures of several pathogenic microbes, with these results :—

1. *Staphylococcus pyogenes aureus.*—He obtained ammonium chloride, and xanthin derivatives, but no toxic body. The micrococci produced little or no effect on glycogen.

2. *Streptococcus pyogenes.*—He only obtained trimethylamine.

3. "*Tetanus bacillus.*"—From an impure culture of this bacillus a basic body was isolated by Brieger; it produced tetanic spasms in mice. It must be mentioned that the microbe supposed to produce infective tetanus has not yet been isolated, as recent research has shown.

4. *Bacillus of typhoid fever* (Koch-Eberth).—From its cultures Brieger obtained a specific ptomaine, *typho-toxin*, *i.e.*, a basic body not hitherto found in cultures of other bacteria. It was formed in meat broth after 8–14 days, and at a temperature of 37·5–38° C. The amount produced was small, and its appearance under such conditions is by no means constant.

*Hoffa** found that from cultures of *anthrax* in meat-broth he could isolate a substance, toxic to frogs, rabbits, and guinea-pigs. This body cannot be considered as in any way associated with the specific pathogenic properties of anthrax. It would be rash to say that the anthrax bacilli produce a similar substance *within* the body. Further, the effects on animals were distinctly due to an intoxication, and anthrax cultures when injected in large amount never produce intoxication symptoms.

Nicati and *Rietsch*† isolated by chemical methods a body from cultures of *Koch's commabacillus*. It produced toxic symptoms in animals.

Berdez‡ states that this substance is only produced in small amount, and that he obtained similar toxic results with cultures of Finkler and Prior's commabacillus, and with cultures of bacillus subtilis. It is clear that we have here to deal with, *not* a specific product, but in all probability a putrefactive ptomaine.

Kitt§ found that the blood of a guinea-pig, dead from malignant œdema, injected into a horse caused death. No bacilli were found in the tissues, but pathological changes had occurred in the blood, which he supposes were due to a chemical poison.

Fraenkel and *Simmonds*‖ have stated that they were able to produce the typhoid process with pure cultures of the Koch-Eberth bacilli. But after injection the bacilli *disappear* very quickly from the blood of the animal (Beunner and Peiper),¶ and Sirotinin's** experiments prove that positive results are due to an intoxication and not an infection, since sterilised cultures produce the same effect as living cultures.

Brieger has lately found an abundant production of *cadaverin* in cultures of Koch's commabacillus. Cadaverin is a typical *putrefactive* ptomaine, and the circumstance is suggestive that the chemical mechanism with putrefactive and pathogenic bacteria may be the same.

According to the latest observations of Hueppe, the production of ptomaines goes on very rapidly in egg cultures, and the amount produced is larger than in meat broth. This statement, however, requires confirmation.

With regard to *infections* arising from *wounds*, ptomaines have been mentioned as the possible causes. But no one has yet isolated any, or adduced any experimental facts in support of the statement. Nor has anyone succeeded in producing *pus*, with the chemical products of bacteria—so far as I am aware.

A discussion of the chemical theory with respect to acquired immunity must be reserved for the next report.

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* Ueber die Natur d. Milzbrandgiftes. Wiesbaden. 1886.
† Recherches sur le cholera. Paris. 1886.
‡ Brit. Med. Journal. 1885.
§ Jahres bericht Thierarzneischule in München, 1884–85.
‖ Zeitschrift für Hygiene. Vol. II.
¶ Zeitschrift für Hygiene. Vol. II.
** Zeitschrift für Hygiene. Vol. I.

Chemical composition of ptomaines and their analogues.

The *basic* bodies resulting from the metabolism of *bacteria* are as follow (the formulæ are only empirical):—

I. The *simple organic ammonias*:—

Methylamine - -	$CH_3 . (NH_2)$.
Di-methylamine - -	$(CH_3)_2 . NH$.
Tri-methylamine - -	$(CH_3)_3 . N$.
Ethylamine - -	$C_2 H_5 . NH_2$.
Di-ethylamine - -	$(C_2 H_5)_2 . NH$.
Tri-ethylamine - -	$(C_2 H_5)_3 . N$.
A base like *Ethylenediamine**	$C_2 H_4 . (NH_2)_2$.

II. *Complex bases*:—

Cholin - - -	$C_5 H_{15} NO_2$.
*Neurin** - - -	$C_5 H_{13} NO$.
*Muscarin** - - -	$C_5 H_{15} NO_3$.
Betain - - -	$C_5 H_{11} NO_2$.
Methylguanidin - -	$C_2 H_7 N_3$.
Gadinïn - - -	$C_7 H_{17} NO_2$.

III. The *Cadaveric ptomaines* as yet isolated:—

Cholin - - -	$C_5 H_{15} NO_2$.
Neuridin - - -	$C_5 H_{14} N_2$.
Cadaverin - - -	$C_5 H_{16} N_2$.
Putrescin - - -	$C_4 H_{12} N_2$.
Saprin - - -	$C_5 H_{16} N_2$.
Trimethylamine - -	$(CH_3)_3 . N$.
*Mydalein.**	

[Leucomaines of Gautier.]

[*Leucomaines* (Gautier).† The name is applied to all those bases which are formed in the body during life, as part of the normal metabolism, *e.g.*, xanthin, kreatinin, &c. They are also found in urine, saliva, &c. Gautier has injected urine into the blood of animals and produced toxic symptoms. Recent research tends to show that a great part of the effect in such cases is due to the *ash* of the urine: the sodium and potassium.‡]

The complete investigation of ptomaines implies an accurate chemical analysis of their constitution, so as to be able to give a rational formula of that constitution.

Synthesis of ptomaines.

Before this is accomplished, we cannot hope to gain an accurate knowledge as to the action of bacteria within the body, *i.e.*, out of what compounds they split these metabolic products. The structure of these bodies can be learned when we are able to prepare them synthetically. The most encouraging achievement in the ptomaine field, since the chemical isolation of these bodies, was made in 1886, when Ladenburg§ prepared *cadaverin* synthetically and proved its identity with pentamethylenediamine, $C_5 H_{16} N_2$.

Further, by quick distillation he transformed the non-poisonous cadaverin into the toxic *piperidin* $C_5 H_{11} N$.

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* These are highly toxic.
† Sur les alcaloides. Paris. 1886.
‡ Zeitschrift für klin. Medicin. 1889.
§ Ber. d. d. chem. Ges. 1886.

The above facts are of great importance. By successful syntheses, we may hope by-and-by to understand out of what organic compounds the bacteria form such bases in the body. The conversion of cadaverin into piperidin shows how, by a simple chemical process (the splitting away of NH_3), a toxic can arise out of a non-toxic body; and how it would be possible for the bacteria, by inducing a similar chemical change within the body, to cause the origin of the most highly poisonous animal substances. We have seen how, by the oxidation of cholin, a poisonous base arises, muscarin. The toxicity of a substance very often depends on a certain radical, the addition or abstraction of which may change the whole physiological action of the body, *e.g.*, Stalnikow* has pointed out the significance of the hydroxyl radical (HO) in various poisons (morphine, phenol, resorcin, &c.). If one exchanges the hydro-oxyl for an indifferent sulphuric acid group the toxicity is lessened and *vice versâ*.

Brieger has suggested that *ptomaines* be used as a generic term for all bacterial basic products, and *toxine* for those of a toxic nature.

All the investigations with regard to ptomaines have been made with *dead* matter. No ptomaine has yet been isolated from the living body, and in the present state of our knowledge it would be rash to say that in both cases the products were the same. Our methods for the isolation of ptomaines are still very incomplete, and where unstable organic compounds are under consideration the difficulties are great For example, cholin is a very unstable body, and it, according to Brieger, is the nucleus of many ptomaines. It has been suggested that the chemical processes employed may account for the formation of some of these bases, *e.g.*, by the action of chloroform and an acid on proteid bodies. Guareschi, however, states that, from decomposing fibrin he has obtained the same ptomaine by the action of chloroform in the absence of, as well as in presence of an acid.

We must carefully distinguish between an *infection*, and an *intoxication*. Many parasitic bacteria can, under certain conditions, produce an intoxication, but the condition induced is not transmissible from animal to animal, as is the case with the infectious bacteria. No one has succeeded in reproducing an *infectious* disease by the injection of bacterial products alone; such effects as have been produced have been due to an intoxication, not to an infection. We are still ignorant as to the special properties in virtue of which pathogenic bacteria produce disease within the body. With regard to the intoxications which arise from the consumption of unwholesome food, they are probably caused by the chemical products of bacteria. The toxicity of cheese does really seem to depend on the base tyrotoxin. Therefore we may conclude that other intoxications are produced also by chemical products, and that their isolation is only a matter of time.

Not yet effected for ptomaines of specific disease.

The formation of specific ptomaines by pathogenic bacteria is a problem to be solved in the near future. As yet we have only separated a few of the putrefactive alkaloids, the majority of which are non-poisonous, and those separated from cultures of pathogenic organisms are of similar constitution. It is a feasible hypothesis that ptomaines may be formed indirectly, *i.e.*, by the interaction of two or more of the bacterial products. The best media for testing the metabolic activity of pathogenic bacteria would be native albumens, *i.e.*, bodies nearest in constitution to the animal organism.

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* Zeitschrift für physiol. Chemie. 1883.

II.

The chemical changes produced by Bacteria in Albumens and Peptones.

On the Chemical Changes produced by Bacteria in Albumens and Peptones; by Dr. Macfadyen.

I propose now to give account of the work done by me for the Local Government Board in 1888–89.

Dr. McFadyen's own researches.

This research was undertaken in further elucidation of the chemical changes effected in proteids under the influence of bacteria, of the manner in which proteids are broken up, and of the nature of the resulting products. By using pure cultures of several bacteria, I sought also to find out how far these products differed from one another, and if any of them might be regarded as peculiar to particular organisms. The foregoing pages will have made clear the importance of this line of investigation.

The subject being still in an elementary stage, has presented many technical difficulties. It has been necessary to begin with the simpler, and advance gradually to the more complex problems.

In submitting the results of my year of work, it will be understood that they are of necessity incomplete, and that the investigation is still in progress.

Organisms employed.

Microbes representing three great classes were employed :—

1. Putrefactive micro-organisms.
2. Pathogenic micro-organisms. Anthrax bacillus.
3. Non-pathogenic micro-organisms. Scurf bacillus (Klein).

Culture media employed.

The *culture media* employed.—I. *Albumens.*—The difficulty of sterilising a native albumen is great, and it was therefore decided to conduct the present series of experiments with a derived albumen. Alkali-albumen was selected and was prepared as follows :—

To the white of an egg were added 20 volumes of distilled water. This was well shaken and strained. After filtering, a solution of caustic soda (0·5 per cent.) was added in quantity sufficient to form a non-coagulable albuminate. The reaction was tested, and if too markedly alkaline, the alkalinity was reduced by addition of acid phosphate of potash. The result was a 5 per cent. solution of albumen. By this means we obtained a liquid albumen which could be easily sterilised. The solutions were each placed in the steam steriliser for five minutes on three successive days.

The albuminate was also prepared in another fashion. The egg albumen was placed in a graduated glass cylinder, and to it were added a solution of caustic soda (1 per cent.) and distilled water in these proportions: 5 C.C. albumen + 3 C.C. alkali solution + 2 C.C. distilled water. After thoroughly mixing, the fluid was sterilised at 95–98° C. If successful a clear consistent culture medium resulted. (Rosenthal and Schulz.) I found, however, that I obtained better results with the former solution.

II. *Peptone Solutions.*—These consisted of peptone 1 per cent. and 2 per cent., sodic chloride 5 per cent. The reaction was rendered neutral or faintly alkaline with sodic carbonate.

All the bacteria grew in these media, and the better in the more concentrated solution.

Experiments with the group of putrefactive micro-organisms.

Experiments with putrefactive organisms.

A. Flasks containing each 100 C.C. of the albuminate (5 per cent.) were inoculated from decomposing albumen, and placed in the incubator at 21° C. They were examined on successive days for decomposition

products. For the first three days peptone reactions were marked. After the third day these became fainter, but never entirely disappeared. The first important change noted was an abundant production of leucine and tyrosin (2nd–3rd day). At the same time ammonia, carbonic acid, and sulphuretted hydrogen were given off. On the fourth day indol was detected, and by the seventh day the indol reaction was most marked.

After distillation on the 14th day the products obtained were fatty acids, indol, and traces of phenol. Butyric acid was the chief fatty acid. Leucine was still present in the fluid, and a trace of tyrosin, also peptones.

B. A series of flasks charged and inoculated in similar fashion, were incubated at 35° C. The peptone reaction, which was present at the beginning, again persisted. Leucine and tyrosin appeared abundantly on the second day, as well as NH_3, CO_2, and H_2S. On the third day the indol reaction was most marked. On distillation after lapse of a fortnight there were detected indol and skatol, butyric acid, valerianic acid, and phenol.

By the 14th day tyrosin had disappeared.

C. It now occurred to me to use a more dilute solution of the albuminate, viz., 2·5 per cent. This was inoculated in similar fashion, and incubated at 35° C. The results were the same as in series B., with this difference, that after 14 days the peptones, as well as the tyrosin, had disappeared, and there only remained a trace of leucine.

To sum up: the results were obtained with a *mixture* of putrefactive *microbes*:—

(1.) A 5 per cent. albuminate at 21° C. gave:—

1. Peptones.
2. Leucine and tyrosin.
3. NH_3, CO_2, and H_2 S.
4. Indol and phenol.
5. Butyric acid—

Remainders.—Leucine, tyrosin, and peptones.

(2.) A 5 per cent. albuminate at 35° C. gave the above compounds + skatol and valerianic acid.

Remainders.—Peptones and leucine. No tyrosin.

(3.) A 2·5 per cent. albuminate at 35° C. gave the same products as in (2.).

Remainder.—Leucine. No peptones or tyrosin.

Thus the completeness of the decomposition depended on certain external conditions, viz.:—the concentration of the fluid, and the temperature. It is easy to understand that in a fluid containing different microbes, the conditions for growth and development will not be alike favourable for all. Some will be most active at a low, others at a high temperature. Any variations that are made in the temperature will favour some microbe at the expense of another.

Specialised.

The next point was to investigate the products of *particular putrefactive bacteria.*

I isolated from putrefying albumen a micrococcus and a bacillus.

A. Alkali albuminate (5 per cent.) + *putrefactive micrococcus* was incubated at 21° C. Again the first products were peptones followed by leucine and tyrosin; NH_3: CO_2: and H_2S. On the fifth day indol reaction appeared. On distilling after lapse of a fortnight, I obtained indol and butyric acid, but failed to detect phenol, skatol,

or valerianic acid. There remained an unchanged remainder of peptones, leucine, and tyrosin.

B. A similarly prepared series of flasks were incubated at 35° C. The micrococcus did not grow well at this temperature.

C. A 2·5 per cent. alkali albuminate + putrefactive micrococcus was incubated at 21° C. Same results as under A.

D. A 5 per cent. alkali albuminate solution + the putrefactive bacillus was incubated at 21° C.

Products:—Peptones; leucine and tyrosin; NH_3; CO_2, and H_2S. On the third day indol reaction appeared. On fourteenth day I distilled and obtained indol, butyric acid, valerianic acid, and phenol; no skatol.

Remainders:—Leucine, tyrosin, and peptones.

E. A similarly prepared flask was incubated at 35° C. The bacillus grew well and gave same results as under D.

F. A 2·5 per cent. solution of albuminate + the putrefactive bacillus was incubated at 35° C.

Again similar products, but the remainder contained no tyrosin.

To sum up:—The *putrefactive micrococcus* gave no phenol, skatol, or valerianic acid. There were remainders of peptone, leucine, and tyrosin.

The *putrefactive bacillus* gave valerianic acid and phenol, but no skatol. Remainders of leucine and peptones. No tyrosin.

The activity of the bacillus was favoured by the higher temperature, that of the micrococcus was hindered.

These experiments show that the putrefactive process is not the same with particular microbes as with a mixture. The more complete decomposition of albumen occurs with a mixture of micro-organisms. The completeness of the decomposition varies also with different bacteria, and with the concentration of the medium. The temperature-conditions for the microbes vary.

I found it was not advisable to continue the experiments longer than fourteen days, as at the end of that time the bacteria were hindered in their growth.

The micrococcus and the bacillus I isolated from putrefying albumen were *aerobic*, but the experiments detailed above lead me to the conclusion that *anaerobic* were also simultaneously present in the putrefying albumen from which I isolated them. The reason for drawing this conclusion are as follows:—the aerobic bacteria which were isolated do not, acting per se on albumen, produce the more complete decomposition that occurs when albumen is inoculated with putrid albumen. The more complete decomposition that occurs in the latter case could be accounted for by the simultaneous presence and growth of *anaerobic* bacteria in the putrid albumen. It still remains for me to make the necessary *anaerobic* cultures, in order to prove the rightness or wrongness of this hypothesis.

Neither of my bacteria gave *skatol*. The bacillus was the more active, though even it did not succeed in completely breaking up the peptones. Thus the *aerobic* putrefactive bacteria differ amongst themselves as regards chemical activity, some being more, others less active.

How does the process differ qualitatively and quantitatively in each case? What are the specific products of the several bacteria? What effect have the products on their producers? What is the function of the anaerobic bacteria? All these questions are suggested by the above results, and only after further research may one hope to answer them. At any rate the complete decomposition is a mixed result. The

effect of the putrefactive chemical products on the microbes must be deferred for consideration on another occasion, in order to find out in how far they hinder the growth of the microbes that produce them, and whether the chemical products of one microbe can hinder the development of another in the same culture fluid.

Production of ptomaines with mixed,

It was next sought to determine the presence or absence of *alkaloidal* bodies (ptomaines) in the fluids in which bacteria had been growing or were growing.

The experiments were carried out by the Stas-Otto process.

To the decomposing albumen was added twice its weight of spirits of wine; and then the fluid was acidified with tartaric acid. The mixture was digested at a gentle heat. After cooling the residue was filtered, and the filtrate concentrated, once more filtered, and evaporated to a small bulk. After extraction with alcohol, the remainder was dissolved in water, and shaken up several times with ether.

This ethereal extract was preserved for examination. We will call it A (acid).

The watery remainder was made alkaline by the addition of caustic soda, and was afterwards shaken up with ether repeatedly = B (alkaline).

The remainder from B + ammonium chloride and extracted with ether = C.

The remainder from C was extracted with chloroform = D.

(1.) 500 C.C. alkali albuminate solution(5 per cent.) were inoculated with a mixture of microbes. This inoculated fluid was then incubated at 35° C. and examined on the sixth day by the Stas-Otto process. The only positive results I obtained were with B, *i.e.*, with the alkaline extract. It yielded on evaporation an oily fluid, of strong smell, and which gave alkaloidal reactions. On the addition of platinic chloride, a salt crystallized out, which gave precipitates with phospho-molybdic acid and tannic acid.

with specialised bacteria.

(2.) Similar culture fluids were inoculated with the putrefactive bacillus and micrococcus respectively. After six days' incubation at 35° C., the fluids were examined by the Stas-Otto process. The alkaloidal body was *not* obtained in either case.

One is therefore led to ascribe its production to some other microbe not yet isolated—unless it be a mixed result also.

There are no doubt other alkaloidal bodies present, but this is the only one I have as yet been able to obtain in a crystalline form. It remains for my further investigation to determine what the other alkaloidal bodies are; in how far they are specific, *i.e.*, associated with individual bacteria, and finally their physiological action.

Changes observed under experiment with *peptones*:—

The solutions of peptones (1—2 per cent.) were treated in the following manner:—

Series A + a mixture of putrefactive microbes. Incubated at 35° C.
Series B + putrefactive micrococcus. Incubated at 21° C.
Series C + „ bacillus. Incubated at 35° C.

A. The first products were leucin and tyrosin.

On the 3rd—4th day; NH_3, CO_2, and H_2S were formed. The indol reaction appeared on the 4th day.

After distillation (14th day), I obtained indol, phenol, and butyric acid. No skatol or valerianic acid was detected.

Remainder—unchanged peptones, as well as leucine and tyrosin.

Of B. The first products were leucine, tyrosin, NH_3, CO_2, and H_2S.

A trace of fatty acids. After distillation (14th day), I obtained indol, but no phenol, skatol, or valerianic acid. Remainder—peptone, and much leucine and tyrosin.

Of C. The first products were leucine, tyrosin, NH_3, CO_2, H_2S, butyric acid. After distillation indol and phenol: no skatol. Remainder—peptones, leucine, and tyrosin.

Whilst the bacillus again proved itself the more active inducer of chemical change, in neither case was the decomposition so complete as with the albuminate. The peptones were not completely broken up. This might be due to the differing nature of the soil, and its attenuating effect on the microbes grown in it. The process has become more or less modified in albumen peptones.

Investigation for ptomaines:—This was carried out in the same way as with the albuminate. In all three cases the results were *negative*, no ptomaines being detected. Thus these experiments tend to show that the microbes do *not* produce alkaloidal bodies in peptone solutions.

It was next sought to investigate the action of *non-putrefactive* bacteria on albumens and peptones.

Commencement of experiments on other bacteria.

Scurf Bacillus (a non-pathogenic microbe).

A. 5 *per cent. albuminate.* Incubated at 35° C. Peptones were rapidly formed. Then leucine and tyrosin; NH_3 and CO_2.

After 14 days no indol, skatol, or valerianic acid was detected. There was just a trace of some fatty acid.

Remainders = *much* unchanged peptone, leucine, and tyrosin.

B. 2·5 *per cent. albuminate.* Incubated at 35° C.

The results were identical with those obtained from A.

C. 2 *per cent. peptones.* Incubated at 35° C.

A large quantity of leucine and tyrosin was formed. No indol, phenol, &c. were obtained. A trace of fatty acids was present.

D. *Alkaloidal bodies*:—Results *negative* with the albuminate and the peptones.

Anthrax Bacillus (a pathogenic microbe).

A. The products were peptones, leucine, and tyrosin, also carbonic acid and a small quantity of fatty acids, which did not contain amongst them butyric acid.

What these fatty acids are I have not yet determined. I am continuing the experiments in this direction, especially with regard to the effect of these chemical products on the development of the bacilli.

B. The 2·5 per cent. albuminate. The results were of a similar nature to those under A.

C. The products were leucine and tyrosin in small amount, as well as a trace of fatty acids. A large remainder of unchanged peptone.

D. *Alkaloidal bodies*:—None were detected either in the albuminate or the peptones. *Hoffa* found that a toxic base was produced in meat broth, but this does not seem to occur with albumen or peptones.

These results seem meagre, but are nevertheless very interesting. It is remarkable how little change the scurf and anthrax bacilli produce in peptones, and yet grow well. One is led to ask the question do they, for purposes of nutrition, regenerate the peptones into a form of albumen,

i.e., dehydrate them? I think this probably occurs, and I will by-and-by communicate some experiments of my own with reference to this point.

In peptones I did not in any case detect *basic* bodies. The profound changes occur in the albumens, not in the peptones.

The most interesting line for investigation is as to the changes that occur in peptones through the action of bacteria, and this I am following up. By means of such investigations with microbes, we may hope also to throw some light on the physiological chemistry of the animal body.

No. 7.

Report on certain Bacteria in their observed Relations with Digestive Processes; by V. D. Harris, M.D.London.

The intestinal canal is well known to contain several species of micro-organisms, some of which are doubtless called upon to play definite parts in the processes of digestion. These micro-organisms, or their parents, have been for the most part introduced into the intestines through the stomach along with the food and drink; and their presence therein suffices to demonstrate that some micro-organisms at any rate are under some circumstances able to resist the action of the gastric juice.

Objects inquiry.

It is obviously of great importance to ascertain what are the circumstances under which micro-organisms pass unscathed through the stomach; to discover whether the presence of micro-organisms in the intestines is due to their power of resistance to, or to their accidental escape as it were from, the full action of gastric digestion; and further to test the action of the gastric juice upon given micro-organisms; and by varying the experiment to establish the nature of the conditions by which a particular micro-organism is destroyed in the stomach in one case and is not destroyed in another case.

If these matters were adequately understood an insight might be gained into the conditions necessary for the infection of the system through the alimentary canal such as undoubtedly occurs in some diseases, *e.g.*, typhoid fever and cholera, and in like manner into the means of preventing infection of the animal body in this way. Many researches have already been made in various directions with a view to settling one or other of the problems which are involved. Such researches have been valuable in many ways, and have given much information upon many points; but so far they have been to all appearance somewhat conflicting in their results.

Accordingly, during 1888, I was instructed to make experiments with a view to determining the effect of passing known bacteria into the stomachs of certain animals by administering them with food or drink, after a period of fasting. So far as these experiments have gone pure cultures of bacteria free from spores have alone been employed. The animals experimented with have been *cats* as representing carnivorous feeders; *mice* as representing mixed feeders; and *guinea-pigs* as representing vegetable feeders.

As a preliminary to attacking the main problem,—*i.e.*, what action the gastric juice of certain animals exerts on specific micro-organisms in spore-

less phases, which is after all a very limited section of a larger subject,—certain experiments were made with a view to discover whether the greatly prolonged action of the natural gastric juice of the above-mentioned animals is sufficient to destroy such micro-organisms as may be supposed ordinarily to enter the stomach along with the food. In the case of micro-organisms thus entering the animal body, and escaping destruction by prolonged action of the gastric juice, considerable time and attention have been devoted to their cultivation and study.

Experiments of previous observers

Before, however, entering on an account of the methods adopted and the results of my several experiments, it will be as well to mention briefly the outcome of previous experiments by other observers directed towards the same end, viz., the determination of the destructive power of the gastric juice, and also the steps by which their conclusions were arrived at.

Firstly, there are the experiments which have been made outside the animal body with artificial gastric juice, that is to say, with hydrochloric acid of various strengths, with or without pepsine in certain proportions.

by use of artificial gastric juice;

The experiments of E. Frank (*Deut. Medicinisch. Wochenschrift*, *No.* 20, 1884, *p.* 310) were of two series, the one made with tuberculous matter, the other with anthrax material. With the first we have no special concern at the present time. His anthrax material was fresh blood, and in some cases pounded spleen, from recently dead animals infected with anthrax for the purpose. His artificial gastric juices were of three kinds, each consisting of—(*a*) pepsine solution alone; (*b*) the same pepsine solution plus hydrochloric acid; and (*c*) a solution of hydrochloric acid alone. In each case 3 to 4 drops of anthrax blood were added to 10 cc. of the pseudo-gastric juice of the experiment. The experiments with the spleen material were made with similar gastric juices (*a*), (*b*), and (*c*), but with different strengths from those employed in experiments with the blood. Frank's results, put very shortly, showed that pepsine alone did not destroy the virulence of the anthrax material, but that the acid alone, as also the acid along with pepsine, did do so.

Falk* using fresh pieces of the spleen of anthrax-infected sheep (either solid or pounded up) found that this material whether exposed to the action of the natural gastric juice for 24 hours at 38°–40° C., or to hydrochloric acid alone in solution above 1·1 : 1,000 strength, lost its power of infection. Falk also found that on some occasions gastric digestion killed anthrax spores; differing herein from Koch, who had found that though gastric juice could destroy the anthrax bacillus itself, it was powerless against its spores.

MacFadyen,† in his paper detailing a number of exceedingly careful experiments with artificial gastric juice, takes exception to the results both of Falk and of Frank on the plea that their experiments were not made with pure cultures, and that no distinction was made between spore-free and spore-containing material. It is true that Frank's experiments were not done with pure cultures, but it seems hardly fair at any rate to infer that in the case of Falk too no distinction

* "Uber das Verhalten von Infections Stoffen im Verdauungs Kanal." Virchow's Archiv., vol. xciii.

† Behaviour of bacteria in the Digestive tract. Journal of Anatomy and Physiology. Jan. 1887, p. 227.

was made between spore-bearing and spore-free bacilli; because he treats separately of the spore-containing anthrax material and goes out of his way to say that the results of his experiments therewith were not constant, since some showed that the gastric juice possessed power to destroy the spores, whereas the majority supported Koch's opinion, that it had no power to do so.

There can, however, be no doubt that MacFadyen's methods were more satisfactory because more definite. He used pure cultures, making distinction always between spore-free and spore-bearing bacilli, and he invariably distinguished between mere arrest of development and actual death of the bacteria. We have here only to do with his experiments with anthrax and with Koch's comma-bacillus; the many other micro-organisms he employed do not now concern us. His experiments were made with pepsine,* previously heated to 100° C., with hydrochloric acid, and with a mixture of the two substances. These were severally mixed with the gelatine nutrient medium about to be used in plate cultivation, and in each instance two drops of a second dilution of a pure culture of the micro-organism experimented with in distilled water was added to the particular medicated medium employed. Control inoculations of non-medicated plates were at the same time made.

The conclusions drawn from his experiments were as follows: (1.) There is no hindrance to growth of anthrax exerted by pepsine acting alone, and, *a fortiori*, no killing of the bacilli. (2.) Hydrochloric acid is the active germicide of the gastric juice, but its action is much less powerful than has been hitherto supposed; anthrax continued to grow in plates containing 0·1% hydrochloric acid. (3.) Pepsine does not help and does not hinder the action of the hydrochloric acid. (4.) The quantity of the pepsine employed does not make any difference.

and by gastric digestion within the living animal.

Secondly, there are the experiments made on the action within the animal body of the natural gastric juice by passing the micro-organisms through the stomach of a given animal. Reference need only be made to the experiments of MacFadyen.† This observer experimented with dogs, whose gastric juice is known to contain much free acid. The plan of experiment was as follows: The animals were fed on a small quantity of lean meat, were then starved for 24 hours, no water being given them during digestion, were then fed on the micro-organism experimented with, and were killed with chloroform four or five hours subsequently. Plate cultivations were then made from the contents of different parts of the alimentary canal. The result of his experiments with spore-free anthrax cultures and with cultures of Koch's comma-bacillus, was that no growth of either of these micro-organisms was found in the gelatine plates.

When, however, to dogs previously starved for 24 hours, 200 cc. of water, containing a quantity of anthrax culture-material or alternatively a quantity of comma-bacilli culture-material were administered, three colonies of anthrax were obtained in a plate culture inoculated from the jejunum, but no growth of the comma-bacillus made its appearance. Some later experiments with dogs, fed with water and comma-bacilli, and killed within an hour of the feeding, gave abundant colonies of the bacillus in the gelatine inoculated with matter from the small intestine.

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* McFadyen says, "I was able to heat it up to 100° C., and so to sterilise when dry, without its losing its properties."

† Journal of Anatomy and Physiology. Apl. 1887, p. 418.

The experiments which have been undertaken during 1888 may be treated of under two heads.

Series I.

Experiments in 1888: Micro-organisms occurring fortuitously within the animal body.

The first series of experiments had for their object the determination whether micro-organisms ordinarily present in foods, water, and air are able to resist the prolonged action of the gastric juice, under circumstances most favourable to its action.

Experimental animals.

For this series of experiments *cats* as representing animals chiefly living upon flesh, and *guinea-pigs* as representing animals chiefly living upon vegetables were employed. Mice as representing mixed feeders were not used.

The exact amount of free acid in the cat's stomach has not been estimated, but it must be considerable. These animals are usually considered to be clean feeders under ordinary circumstances, but they will freely eat tainted meat. Guinea-pigs are very clean feeders. The different species of micro-organisms which pass into the stomachs of animals must be very numerous. They must include the usual air germs, as well as those which are specially found in connexion with decomposition. Many of these find, under ordinary circumstances, a favourable nidus in the mouth and develop there with considerable activity.

Flügge* states that although by microscopic examination the varieties of buccal micro-organisms appear to be many, yet few can be isolated. This is apparently contrary to the researches of Miller,† who has isolated no less than 25 different forms of bacteria from the saliva. The numbers of micro-organisms which pass into the stomach of vegetable feeders are however probably much fewer than in the case of flesh feeders, and for this reason the two kinds of animals mentioned above were experimented with, in order to contrast the one with the other.

Experimental method.

The method of experiment was as follows :—The experimental animal was fed at a certain time with a full meal of its usual food :—in the case of the cats, with recently cooked lean meat and a little milk; and in the case of the guinea-pigs with clean cabbage leaves, carrots, potato, or corn. The remains of the meal were entirely removed out of reach of the animal, and it was afterwards kept without food for 24 hours (more or less, as is shown in the subjoined tables). After a determined number of hours had elapsed the animal was killed; generally by bleeding—as in one case when chloroform had been used for the purpose, considerable regurgitation of bile into the stomach had taken place. The abdomen was opened with usual precautions, and the stomach pulled forwards with sterile forceps, and opened in one or more places with sterile scissors. Into each opening a sterilized platinum wire was inserted, and a scraping of the mucous membrane taken therewith. With the material thus obtained tube cultures were made upon nutrient peptone gelatine, and the tubes were placed in an incubator at 20° C. The tubes were carefully watched, and if any growths appeared they were used to make further plate cultivations by the process of dilution. The growths on the plates were carefully studied and examined, both fresh and when stained, the staining reagent mostly employed being Weigert's aniline

* Die Mikro-organismen, 1886, p. 310.

† Einige gasbildende Spaltpilze des Verdauung stractus (Deutsche Med. Wochenschrift, No. 8, 1886).

gentian violet solution. By these means it was possible to isolate individual organisms the growth of which in gelatine tubes was further watched. Potato cultures were also employed.

TABLE of EXPERIMENTS to determine the different SPECIES of MICRO-ORGANISMS present in the Stomach after a fasting Period of Twenty-four Hours and upwards.

No.	Experimental Animals.	Lapse of Time between last Meal and Death in Hours.	Post-mortem Condition of Stomach.	Re-action of Stomach.	Species of Micro-Organisms obtained therefrom.
1	Guinea-pig -	24	Collapsed and empty.	Acid - -	None.
2	Guinea-pig -	26	Nearly empty; only a small amount of grumous brown fluid.	Strongly acid -	Two (*a*).
3	Guinea-pig -	28	Not completely empty.	Strongly acid -	One (*b*).
4	Cat - -	26	Contained some regurgitated bile.	Neutral - -	Two (*c*).
5	Cat - -	24	Contracted and empty; dry.	Strongly acid -	No growths of micro-organism. Moulds only.
6	Cat - -	24	Empty - -	Strongly acid -	Two (*d*).

TABLE of EXPERIMENTS to determine the different SPECIES of MICRO-ORGANISMS present in the Stomach within a few Hours of consumption of Food.

No.	Experimental Animals.	Lapse of Time between last Meal and Death: in Hours.	Post-mortem Condition of Stomach.	Re-action of Stomach.	Species of Micro-Organisms obtained therefrom.
7	Guinea-pig -	4 hours -	Nearly full of digesting carrot.	Acid - -	One, but very few colonies (*e*).
8	Cat - -	4 hours -	Partly full of digesting food.	Acid - -	Two only, but a very large number of colonies (*f*).
9	Cat - -	5 hours -	Do. - -	Acid - -	Do. do. (*g*).

Notes on the Species of Micro-organisms found.

Results.

Of the four guinea-pigs used, in one there was no growth whatever obtained on inoculation of culture tubes with matter from the gastric mucous membrane. In all of the other cases there were very few colonies in each cultivation (in No. 7 there were only about half-a-dozen),

although two or possibly three species of micro-organisms could be made out and isolated. The cultivation from the gastric mucous membrane of the five cats showed growths of micro-organisms in four instances. The growths from all of these cats were remarkably alike.

Particulars are as follows :—

(*a.*) *No.* 2, *Guinea-pig.*—The two species of micro-organisms which were isolated from this case were :—

1. Very superficially growing semi-transparent growths in larger or smaller rounded colonies, not liquefying the gelatine nor growing into its substance deeply; producing a faintly disagreeable odour. They consisted of stout motile bacilli of various sizes; one rounded end of the bacillus showing marked spore formation. They appeared to resemble the bacillus saprogenes (1) of Rosenbach more than any other variety of micro-organism.

2. Rapidly growing colonies, producing first of all an umbilication of the gelatine, liquefying it with moderate rapidity, and producing a cloudy fluid with whitish sediment. They consisted of motile bacilli corresponding probably to bacillus subtilis.

(*b.*) *No.* 3, *Guinea-pig.*—The single species noticed in this case was precisely similar in its mode of growth to the preceding form (*a.* 2).

(*c.*) *No.* 4, *Cat.*—Two species of growths could be made out in this case.

1. About six colonies; more or less opaque whitish yellow, growing in regular and circular fashion; not growing rapidly or liquefying the gelatine. Appearing under a low power, in zones not unlike a carbonate of lime calculus. In tube cultures, growing along the needle line around minute foci, not liquefying the gelatine. They consisted of very small bacilli with rounded ends, the protoplasm collected chiefly into the ends of the rods. At first sight, under the microscope, the organisms appeared to be micrococci. In addition there were in the tube about four colonies of a semi-transparent white shiny-looking growth; not liquefying the gelatine, growing in irregular colonies, and growing but slowly in depths of the culture medium. Although growing somewhat differently to the above, they appeared under the microscope to be similar organisms.

2. Rapidly growing colonies, superficial not deep, semi-transparent, not liquefying the gelatine; very similar in mode of growth to (*a.* 1).

(*d.*) *No.* 6, *Cat.*—In this case, out of six tubes inoculated with scrapings from the mucous membrane of three separate districts of the stomach,—viz., from the œsophageal part and from the greater and lesser curves respectively,—there was at once in four out of the six a great growth of moulds and a very sparse growth of colonies of micro-organisms. In the other two tubes moulds only were seen. The colonies were of two kinds.

1. Semi-transparent, white, slowly growing and rounded, small for the most part, growing slowly also in streak cultures, not liquefying the gelatine, appearing along the line of inoculation in small bead-like foci. These in microscopical appearance and mode of growth are similar to (*c.* 1).

2. Yellowish rounded colonies larger than the above, growing more quickly, and not liquefying the gelatine. In tubes, growing in a thick

moist uniform line, light yellowish-brown in colour, not unlike a line of yellow paint. A considerable amount of trouble was required before these could be obtained pure. They consisted of regular, medium-sized, micrococci in groups.

(*e.*) *No.* 7, *Guinea-pig.*—This organism is similar to *a.* 1 and to *b.*; it consists of motile bacillus-forming spores, almost certainly the bacillus subtilis.

(*f.*) *No.* 8, *and* (*g.*) *No.* 9, *Cats.*—In these cats the micro-organisms obtained from the stomach were similar, and of two kinds :—

1. Pale-yellow colonies, round, superficially and not rapidly growing, not liquefying gelatine. These are very similar to *a.* 2. They consisted of micrococci alone, of different sizes and generally arranged in groups.

2. White, semi-transparent, superficially growing, rounded colonies, not liquefying the gelatine. Moist looking. In all probability the same as (*a.* 1) and (*c.* 2). They consisted of stout bacilli, having rounded ends; along with them were micrococcus forms.

From the foregoing it will be seen :—

Summary.

(1.) That in some cases (in two out of six) no micro-organisms could be cultivated from the stomachs of animals after a fasting period of 24 hours.

(2.) That in the remaining four cases the species of micro-organisms which could be cultivated were few in number. They appeared to be either micrococci or spore-forming bacilli.*

(3.) That when the fasting period was of a few hours' duration only, micro-organisms were present in each case, but that the species capable of growth were not greatly increased in number.

And it may be inferred :—

(4.) That few of the many kinds of micro-organisms introduced into the stomach along with food and drink are able to survive for four hours the action of the gastric juice, and that still fewer survive that action when it is prolonged for 24 hours and upwards. It is probable, therefore, as regards the many species of micro-organisms found in the intestinal tract either that they have passed quickly through the stomach ; or that during their detention in the stomach the action of the gastric juice was not being energetically exerted ; or finally that they have passed through the stomach in the spore condition. It is by no means to be assumed, however, that what is true of the spores of certain micro-organisms, as regards resistance to the action of the gastric juice, is true likewise of all spores.

Series II.

Micro-organisms purposely introduced within the animal body :

The second series of experiments was directed to ascertain whether particular pathogenic micro-organisms, viz., the anthrax bacillus, and the comma-bacillus of Koch, can be recovered from the intestines after having been administered to cats and to mice along with food.

It will be recollected that, speaking generally, the majority of former observers, experimenting chiefly with mice, guinea-pigs, and dogs, have

* B. Bienstock, Uber Die Bakterien der Fäces (Zeitschrift für Klin Med., vol. viii., 1884, p. 7) appears to think that micrococci are destroyed by the gastric juice.

found that anthrax bacilli free from spores are destroyed in the stomach; and that Koch's comma-bacilli meet there with the same fate. MacFadyen,* however, has shown, as already mentioned, that if given in water to starving dogs, anthrax bacilli not containing spores will pass through the stomach unscathed, and may be recovered from the intestines; and, further, that Koch's comma-bacilli given to dogs in water may likewise be recovered from the intestines if the dogs are killed within an hour.

experimental method.

In this series of experiments the following method was used:—The animal to be experimented with having been kept for 24 hours without food, the typical fluffy sediment only of a broth culture of spore-free anthrax was administered to it mixed along with milk or other food. At a determined time after this feeding the animal was killed. Its intestines in certain districts were then opened with antiseptic precautions, and scrapings of the mucous membrane were taken with a platinum wire. These scrapings were next thoroughly distributed, in a sterilized test tube, through sterilized saline solution (0·6%) by vigorous shaking. From this saline solution, gelatine-peptone plate cultivations were made by the dilution process. These plate cultivations were watched from day to day, and the growth of colonies of micro-organisms noted. Cover-glass preparations of them were also made and examined from time to time. If any colony exhibited in its mode of growth or in its appearance under the microscope any likeness to anthrax, sub-cultures were made of it. If the growth still exhibited a likeness to anthrax, it was introduced by means of a capillary pipette into the subcutaneous tissue of the thigh of a guinea-pig or of a white mouse. The only evidence which was considered to be conclusive of a suspected growth being anthrax, was that when introduced into an animal susceptible of anthrax it produced therein the characteristic symptoms of that malady followed by death, with the post-mortem appearances peculiar to the disease.

In some cases (indicated in the annexed table), instead of the broth culture of the organism, anthrax was administered in the form of the spleens of animals which had recently died of the disease. These were either pounded up with food; or were administered in the solid form to mice, as they will eat it freely in that condition.

In the case of the comma-bacilli, great care was taken to procure pure cultures. For the rest, the method of administration and of after experiment was essentially the same as with anthrax; but the presence or absence of the particular micro-organism in the plates could of course only be tested by the mode of growth and by the microscopical appearance of the various colonies.

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* Loc. cit.

Table of Experiments with Spore-free Anthrax Material.*

	Experimental Animals.	No. of Hours antecedent Fasting.	Anthrax how administered.	How killed, and how soon after Anthrax administration.	Post-mortem Condition of Stomach.	Parts of the Alimentary Canal examined.	Gelatine Plates inoculated.	Result of Culture of Specimens.
1	Cat, large, young, and well nourished female.	27	The sediment of broth culture, administered in milk.	Chloroform and bleeding, 4 hours after administration.	Collapsed and empty	i. Duodenum. ii. Jejunum. iii. Ileum.	2	No anthrax growths.
2	Cat, black female	24	In milk	Do., 3½ hours	Acid in re-action	i. Stomach. ii. Middle duodenum. iii. Lower ileum.	2	Do.
3	Cat, small black female, pregnant.	26	Anthrax from broth culture, administered in milk.	Do.	Empty. Acid in re-action.	Middle of small intestine.	1	Do.
4	Mouse	24	Spleen of guinea-pig mixed with food.	Do., 2½ hours	Partly full. Acid	Middle of small intestine.	1	Do.
5	Mouse	24	Do.	Do., 2 hours	Do.	Duodenum	1	Do.
6	Mouse	24	Do.	Do., 3 hours	Do.	Do.	1	Do.
7	Mouse	24	Do.	Do., 3 hours	Do.	Do.	1	Do.
8	Guinea-pig	24	Do.	Do., 3 hours	Do.	Do.	1	Do.

* Since completing the above table, two or three other experiments not quite in form to be included in it have been sufficiently advanced to enable one to say that they are in accord with the results of the experiments included in the table.

From the foregoing table it will be seen that in the experiments with three cats, one guinea-pig, and four mice, no anthrax cultivations were obtained from the intestines 2 to 4 hours after administration, by the mouth, of what is to be regarded as spore-free anthrax material. These experiments then go to support the statement that anthrax bacilli not containing spores are destroyed in passing through the stomachs of certain animals. And upon the whole they perhaps indicate for cats and mice a somewhat greater destructive power of the gastric juice than would appear from MacFadyen's experiments to be possessed by that of the dog.

Table of Experiments with Koch's Comma-Bacillus.

No.	Experimental Animals.	Antecedent Fasting, and Interval between Administration of Comma-bacilli and Death of Animal.	Comma-bacillus; how administered.	Post-mortem Condition of Stomach.	Part of Alimentary Canal examined.	Result of Culture of Specimens
1	Cat, medium size female.	24 hours. Cat killed with chloroform 3½ hours after administration.	Cultivation in sterile broth, given in milk.	Stomach and intestines collapsed and empty.	Middle of ileum.	No appearance of comma-bacilli on gelatine plates.
2	Cat, old, full-grown tabby.	24 hours. Killed 4 hours after administration.	With meat -	Empty -	Middle of small intestine.	No comma-bacilli colonies.

From the above experiments on cats (those only as yet completed) support is afforded to the statements of Koch and others that the comma-bacilli are unable to resist the action of the gastric juice.

Some additional experiments, not yet completed, go to show that anthrax spores are able to resist for many hours the action of the gastric juice.

London: Printed by Eyre and Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.